THE GLASS INDUSTRY

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LAMB GLASS ADOPTS LUMINOUS-FLAME FIRING

The Mt. Vernon tank has recently been rebuilt and now is being operated with a controlled method of luminous-flame firing. The fuel is natural gas and the installation has many features of interest.

During the latter part of last year one of the melting tanks in the plant of the Lamb Glass Co., well-known manufacturer of milk bottles at Mt. Vernon, Ohio, underwent a rebuilding program that included changes in design and construction, together with the application of controlled luminous-flame firing. The new tank was completed about the first of the year and records from several months of operation indicate good economy, satisfactory product, and excellent facility for control under varied operating conditions. The redesign and rebuilding of the tank was placed in charge of the Toledo Engineering Co., and this company's method of adjustment and control for luminous-flame firing was applied. Since the utilization of a luminous type of flame for glass melting is being carefully scrutinized by many glass manufacturers, THE GLASS INDUSTRY deems it timely to present to its readers a description of this application in some detail.

Except for the firing arrangements, the new tank follows conventional design in most respects. It is of the side-port, regenerative type with four ports on each side of the melting zone, the checker chambers being located above the air flues without intermediate passages or dampers. Before reconstruction the furnace was charged through two doghouses by means of mechanical feeders, but batch is now fed manually through a single doghouse in the center. Fig. 1 shows the rear end of the tank, together with the charging platform and the batch-handling apparatus.

The batch is prepared and mixed in a separate building adjoining the furnace room and is elevated to a steel storage bin mounted on the building structure above and to the rear of the tank. A gate in the bottom of the storage bin is operated by means of a long handle, which can be seen in the upper right-hand corner of Fig. 1, and the batch is discharged into a trolley bucket that runs on rails from the bin to the doghouse. A handwheel controls the discharge gate in the bucket and the amount discharged can be ascertained by inspection of the level of material through small windows in the side. Batch is fed into the furnace every 20 minutes, the amount depending on the production requirements.

The melting end of the tank is 18 ft. wide by 37¼ ft. long, providing a total area of 670½ sq. ft., and the flux depth is 42 inches. The corners at the opening from the doghouse are composed of special Corhart blocks, so shaped that the passage widens rapidly as the batch passes from the doghouse into the melting zone. Flux blocks are used throughout the rest of the lower structure, except for the throat cover. The throat is of the submerged type, 2 ft. wide and 12 in. deep, with a submerged length of 6½ ft. The center of the nose of the tank is 6 ft. forward of the bridge wall, the inside radius being 10 feet. A shadow wall surmounts the center of the bridge wall.

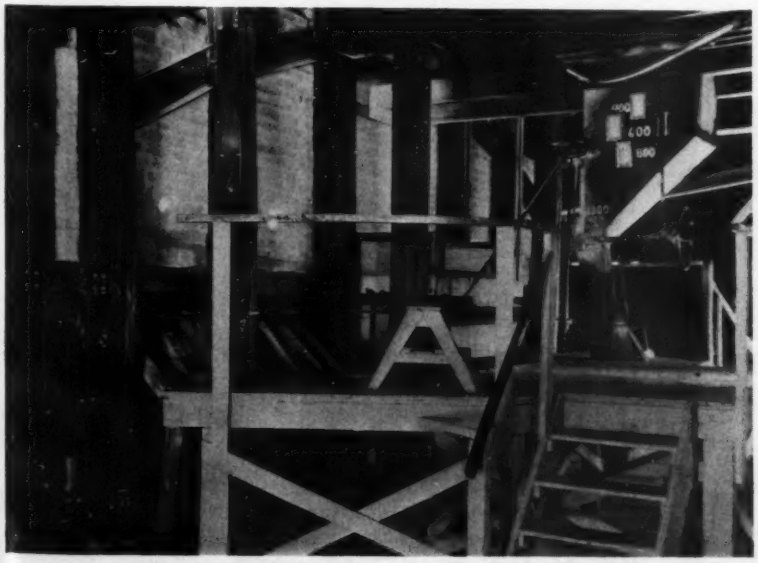


Fig. 1. This view at the rear of the new tank at Lamb Glass Co. shows the charging platform, the single doghouse at the center, and the trolley bucket used to transfer batch from a storage bin above to the furnace.

Silica is used throughout the upper structure, an interesting variation being found in the side walls of the melting end which are 18 inches thick. Use of silica brick in the port jambs follows regular practice of this builder in the construction of luminous-flame furnaces. As stated before, there are four ports on each side, the first three having a width of 3½ ft. and the fourth being 6 in. narrower. All ports have a height

Fig. 2. This fan provides most of the combustion air for the tank. It has adjustable inlet vanes and uses from 3 to 3½ hp. in regular operation.

of about 2 ft. Checkers are constructed of first quality firebrick, 9 x 4½ x 3 inches.

On the floor of each port neck, and at a distance of about 3 ft. back from the port opening, a baffle wall 9 in. high extends clear across the passage, this wall serving to separate the air and fuel gas streams as they pass through the port into the furnace. The burner blocks for the incoming fuel gas are located in the side walls of each port passage, their location being such that the gas is introduced just in front of the baffle on the side toward the furnace. A single large checker chamber serves all four ports on one side and the amount of combustion air flowing varies from port to port, but the firing control used on this tank permits exact regulation of each flame, as will be explained in detail later.

Fig. 3. From the combustion-air fan in the far corner the discharge pipe passes along the back wall of the furnace room and down through the floor to the air valve. The orifice for metering the air is located in the straight horizontal section.

The heart of the Toledo Engineering control system is the introduction of a part of the air for combustion with the fuel gas itself, and the dilution of this air by waste gases when the flame needs to be lengthened. Since the proportion of air to fuel gas in the incoming mixture is never more than one part of air to one part of gas, the mixture is never in the explosion range, but a wide variation in the gas velocity through the port is possible through adjustment of the amount of air in the mixture. The gas velocity is adjusted to be approximately equal to the velocity of the incoming air from the checkers and the gas and air then enter the furnace in superposed layers. Combustion takes place slowly between the layers, the hydrocarbons break down, and the incandescent particles of carbon impart luminosity to the flame.

It is apparent that this kind of control necessitates accurate adjustment of the air supplied to the furnace and continuous maintenance of the proper fuel-air ratio. Natural draft presents too many variables for nice control of the incoming combustion air, so the air is supplied by a fan and carefully metered. The combustion air fan for the Lamb Glass furnace is shown in Fig. 2. It is located in a corner of the room at the rear of the furnace and was furnished by the Buffalo Forge Co. It is driven by a Louis Allis 7½-hp. motor and actually uses from 3 to 3½ hp., the full-load capacity being 11,500 c.f.m. at 1¾ in. static pressure. The fan is of the limit-load type and is equipped with adjustable inlet vanes, so that the amount of air supplied is under accurate control at all times.

The 30-in. outlet pipe from the fan rises vertically and then passes along the rear wall of the building, this straight section providing a suitable location for the metering orifice. The orifice is located in the next to the last flange of the straight section and the small pipes leading to the meter can be seen rising out of the top of the pipe in Fig. 3. When the pipe reaches a point above the air valve it turns downward, passes through the factory floor and ends in a sheet-steel hood on top of the valve. The hood has an emergency door, as shown in Fig. 4, so that natural draft air can be used in case of accidental stoppage of the fan. This illustration also shows the air-valve lever, together with the cables from the operating winch on the factory floor above. The furnace is reversed by hand at 20-minute intervals.

As mentioned previously, not all of the air for combustion is supplied by the main fan, an amount approximately equal to the volume of fuel gas being introduced with the gas. The fan which supplies this "control" air is located in a small room in the basement behind the air valve and is shown in Fig. 5. This Buffalo Forge special fan is equipped to handle hot gases and is driven by a 3-hp. motor at 3600 r.p.m., full-load capacity being 350 c.f.m. at 7.7 oz. pressure and 600 deg. F. The actual power requirement on this job is 1.7 hp. Air enters the fan through the screened opening that appears in the illustration and is discharged through a vertical pipe leading to valves above the factory floor.

It will be noted that a second pipe also enters the fan inlet, at right angles to the air pipe. This pipe passes back of the air valve and down into the stack flue from

Fig. 4. After passing through the floor the combustion air pipe ends in a hood on top of the air valve in the basement. The hood has an emergency door so that natural draft can be used in case of accidental stoppage of the forced-draft fan.

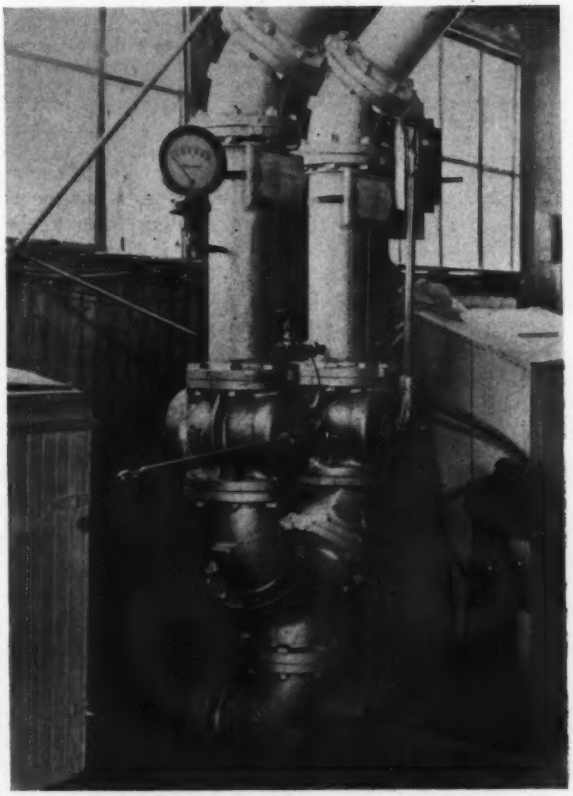
Fig. 5. This special, 3,600-r.p.m. fan supplies the "control" mixture to be added to the fuel before it enters the burners. The screened opening is the air intake and the horizontal pipe at right angles draws waste gases from the stack flue.

which it draws waste gases when required. Both branches of the inlet tee are fitted with butterfly valves, the valves being so geared together that when one is closed the other is wide open. By means of a convenient handle the valves can be manipulated to provide air only, waste gases only or any desired proportion of the two. The fan discharge pressure is about 10 oz. when handling waste gases only, and about 20 oz. with air only.

As shown in Fig. 6, the discharge pipe from the "control" fan enters the furnace room through the back wall near the floor and divides into two branches, each of which serves one side of the tank. The piping and fittings are 8-in. and each branch is furnished with an 8-in. lubricated plug valve, made by American Car & Foundry Co. These valves are used to reverse the control air or mixture from one side of the furnace to the other. Just above the valve a by-pass leads some air into the closed branch, thus keeping a slight amount of air flowing through each line in the direction of the furnace at all times. With this arrangement there is no lag in the action of the control mixture at the burner after reversal.

Natural gas is piped into the factory at the regular line pressure of about 12 lbs. and is passed through a Merian mercury-column gauge to a regulator. The 6 x 8-in. regulator is of the low-pressure balanced type and was furnished by the Equitable Meter Co. It functions as a throttle valve on this job, as well as a regulator, as the usual method for increasing or decreasing the amount of fuel flowing to the furnace is to vary the regulator pressure by changing the weights on the balance. This method of fuel adjustment is very flexible, accurate and convenient. The regulator can be seen on the floor in Fig. 7, at the far right.

Fig. 6. The "control" mixture line enters the furnace room and divides into two branches, one for each side of the furnace. Each branch has a lubricated plug valve for reversal. The air-valve reversing winch is located nearby.



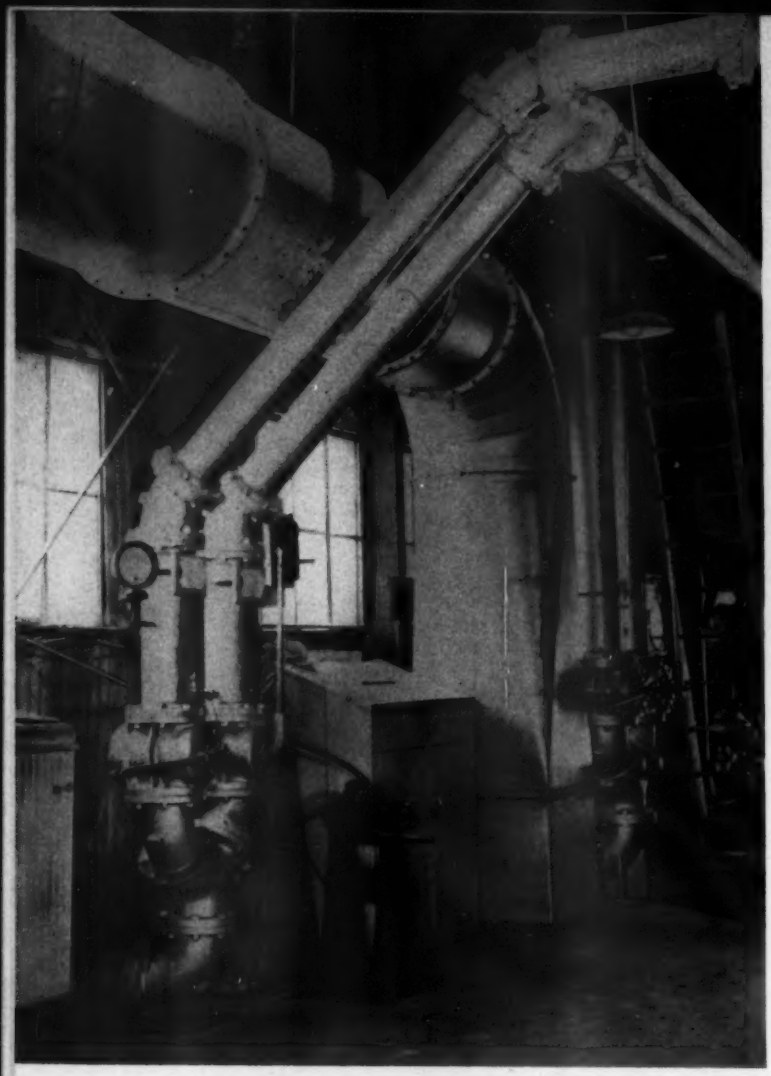


Fig. 7. Natural gas enters through the regulator on the floor at the far right, passes through a metering loop, and the line then divides into two banches leading to opposite sides of the tank. Lubricated plug valves are provided in each branch for reversal.

The discharge pipe from the regulator makes a "metering loop" that consists of a vertical pipe, a horizontal section, and another vertical pipe leading down to the valves. The orifice for the gas meter is located in the horizontal part of the loop. At the bottom end of the second vertical pipe of the loop a return bend leads the gas to a Y-fitting, the branches of which lead to opposite sides of the furnace through the same type of plug valves as those used with the control mixture. These valves appear at the right in Fig. 7 and are also shown in a closer view in Fig. 3.

From the orifices in the combustion air and fuel gas lines small pipes lead to a Bailey fuel-air ratio recorder, shown in Fig. 8. This recorder is of the familiar double-pen type and is adjusted to indicate the proper ratio between fuel gas and combustion air when the pens are together. When a change in the amount of fuel gas is made for the purpose of raising or lowering the temperature, the amount of combustion air furnished by the large fan is adjusted by changing the fan inlet vanes, the amount of change necessary being indicated by the position of the pens in the ratio recorder.

From the four plug valves four pipes lead to the furnace, two on each side including one for fuel gas and

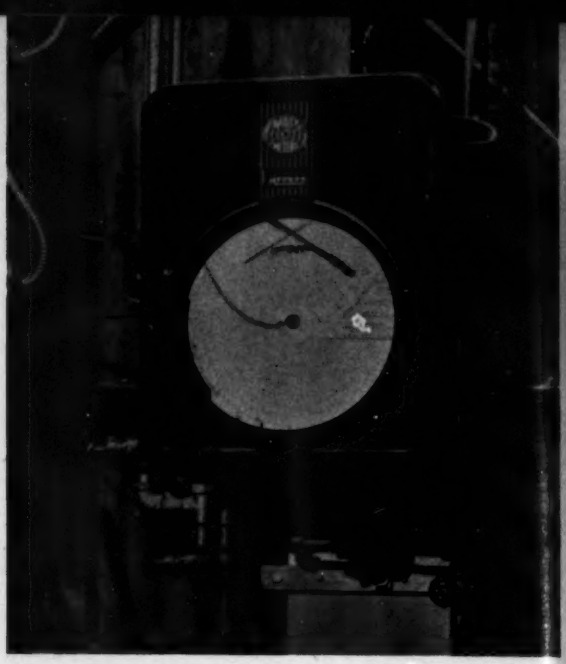


Fig. 8. This fuel-air meter is of the double-pen type and indicates necessary changes in the air supply from the fan to suit variations in the fuel consumption.

one for control air. The position of these pipes at the furnace is shown in Fig. 9, which is a view looking down the side of the tank from the rear. The gas pipe passes along the top of the port walls, the control air pipe turning downward and passing along the bottom. Eight small pipes lead downward from the fuel line through A. C. F. plug valves and then pass horizontally along the port side walls to the burner blocks at the side of each port. Likewise, small vertical pipes from the control air line rise through similar valves and also pass along the side wall toward the burner blocks. The horizontal leads can be seen at the right in Fig. 9, the gas line being 2-in. and the control line using 1½-in. pipe.

Just before the control line reaches the burner block it passes through a tee and the fuel gas line is also connected to this fitting, as shown in Fig. 10. It is here that the fuel gas and control air are mixed together just before passing into the burner. What might be called the burner is simply a piece of straight pipe passing through the hole in the burner block and delivering the fuel mixture at one end of the baffle wall in the port.

The multiplicity of valves in the fuel and air lines leading to the burners seems very complicated, but as a matter of fact these valves are rarely in need of adjustment after the initial setting has been made. The initial adjustment has two objectives: first, to supply the proper amount of fuel to suit the amount of combustion air passing through each port; and second, to make the velocity of the gas stream through the port approximately equal to the velocity of the air stream above it, the gas stream velocity being increased by the addition of control air to the fuel gas before it enters the port. While these adjustments are being made the flame is observed through a peep-hole in the wall of the port, all four valves for controlling the combustion being at the same time within easy reach.

Another use of these control valves is to balance the flame across the port and thus secure a wide flat flame with maximum covering power. The adjustment possible with the entire valve arrangement is very flexible and secures the best possible combustion from each port,

Fig. 9. In this view along the side of the tank the upper large pipe carries natural gas and from it small pipes lead through plug valves to each side of each port. The lower pipe supplies "control" mixture through similar small pipes and valves.

although the volumes and velocities of combustion air flowing are necessarily different in different ports. The goal is the achievement of a flat layer of luminous flame from the four ports on either side of the furnace. It is not only possible to do this, but also to carry a heavier flame near the charging end and produce a gradient of temperature through the melting zone.

While the initial adjustments are being made, no waste gases are added to the control air and the luminous flame will not orinarily reach clear across the furnace. As soon as the flame from each port has been given the proper shape and velocity, however, waste gases are added to the control air by manipulating the valves in the control fan inlet. The dilution of the fuel-air mixture in the burner by means of the inert gases retards combustion of the fuel and causes the flame to lengthen as the proportion of waste gas is increased. In this manner the flame can be made to reach just across the furnace under all conditions, heavy load, light load, or even during a week-end shut-down. Control of the flame length is a very important feature of the Lamb Glass installation, since it provides maximum flame coverage at all times and prevents burning of fuel in the outgoing checkers.

In the estimation of the management at Lamb Glass Co., the new tank is proving entirely satisfactory. Thus far the tank has been melting a maximum of about 90 tons per day, this being the limit of machine capacity. Operation records indicate a low fuel cost and that the percentage packed is high. But it is from the operating standpoint that perhaps the most gratification is expressed, on account of the facility with which the furnace can be controlled for varying production requirements and the practical elimination of delays and shutdowns resulting from bad glass conditions.

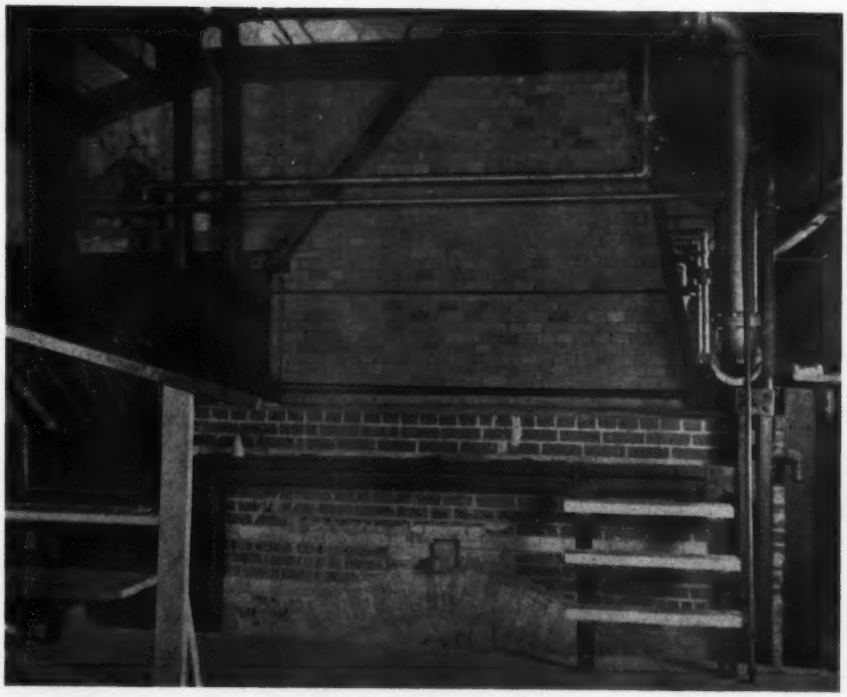


Fig. 10. The top one of these horizontal pipes leading to a burner carries natural gas and the lower one "control" mixture. Near the burner at the left the gases and air mix in a pipe tee and pass through the burner block into the port.

BOTTLES FOR INTERNAL PRESSURE

By FRANK W. PRESTON

This laboratory at not infrequent intervals receives inquiries from glass manufacturers and others as to the suitability of particular designs of bottles for holding internal pressure. Sometimes it does not receive those inquiries until the design has been tried and found wanting. In at least one instance a very serious accident occurred, in fact a fatal accident, through the use of very moderate internal pressures in a bottle whose shape was utterly unsuited thereto. In another instance a bottler of carbonated beverages wanted to use a square siphon or seltzer bottle and, of course, it was found in the preliminary tests that square siphons could not be made to hold anything like the necessary pressure.

In bottle making, as in every other branch of industry today, aesthetic and artistic considerations are becoming vastly more important than they were a generation or two ago. It is no longer sufficient for either automobiles or bottles to be functionally sound. They have to provide some aesthetic appeal. Again, there is an ambition on the part of every vendor of any bottled product to have what he calls a "distinctive" package, and the search for distinctiveness has produced some packages that can fairly be described as artistic and others that can only be described as bizarre. But in any case, whether we are looking for the ornamental or the grotesque, the functional soundness has to remain, and some disappointment is caused every now and again when this laboratory is obliged to declare itself opposed to certain artistic innovations.

Apart from artistic innovation, pure and simple, there are other matters such as ease of handling. Certain large bottles can be held much better in the hand if the shape is modified from that which is perhaps most suited to holding internal pressure. All these things have to be considered.

In general, pressure ware is made in the form of "round" or cylindrical bottles which are quite well adapted to holding the pressure. In the present article we wish to point out how it is that any large departure from the circular shape of a bottle calls for a great deal more glass or a great reduction of internal pressure before the thing is adequate.

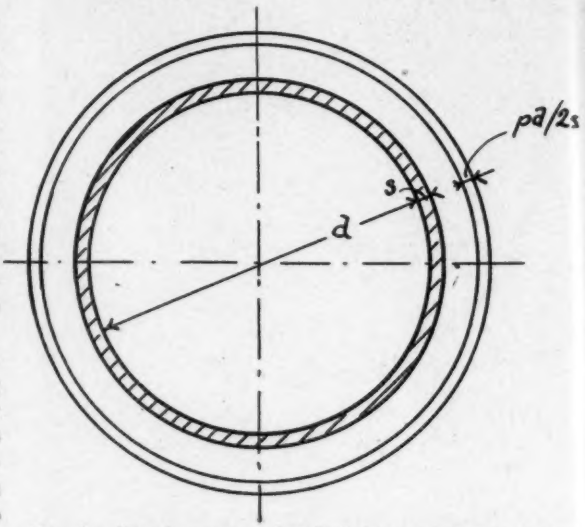


Fig. 1. The inner cross-hatched zone represents a cross-section of a cylindrical bottle. The outer circles represent a stress diagram in which the peripheral tension at the outer face at any point is plotted radially outwards from a circular base line. Since the tension is equal at all points, the diagram consists of two concentric circles. 1/5 reduction.

The simplest cases to consider are those of round bottles and square bottles respectively. In Figure 1 is shown diagramatically a section through a round bottle and outside it is plotted a sort of stress diagram. This stress diagram is plotted radially, and indicates that at all points around the periphery there is an equal stress. The stress is tangential, but is plotted radially. Its value is given by $f = pd/2s$ where f is the tangential tension, p is the internal hydrostatic pressure, d is the internal diameter, and s is the thickness of the sidewall.

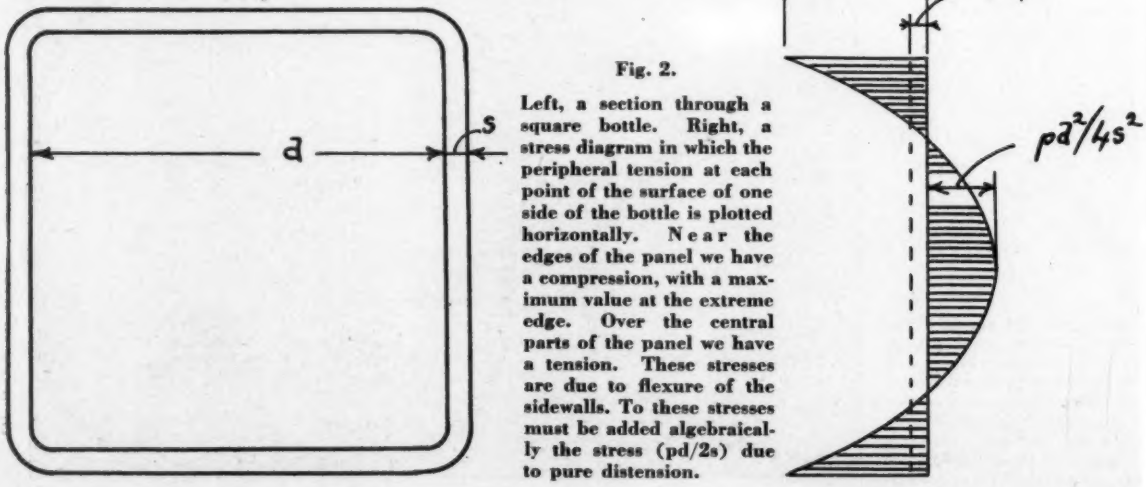


Fig. 2.

Left, a section through a square bottle. Right, a stress diagram in which the peripheral tension at each point of the surface of one side of the bottle is plotted horizontally. Near the edges of the panel we have a compression, with a maximum value at the extreme edge. Over the central parts of the panel we have a tension. These stresses are due to flexure of the sidewalls. To these stresses must be added algebraically the stress (pd/2s) due to pure distension.

Fig. 3.

Actual cylindrical bottle, average wall thickness 0.110″, strength averaging 225 lb/sq. in. 1/5 reduction.

In Figure 2 is a diagramatic section through a square bottle. The internal pressure again tends to enlarge the bottle and stretch its sides. This produces a stress

$$f_1 = pd/2s \text{ as before}$$

But in addition to this distension, there is a tendency to distort or "belly-out" the sidewalls. This flexing action produces a much more serious stress than the direct stretching.

The sidewalls may be considered as essentially equivalent to "built-in girders" and the bending moment diagram is indicated (for one side) in Figure 2a. Here we plot horizontally the stress developed in the outermost skin of the glass, and it may be shown that it is tension over the greater part of the width of the panel, and compression near the corners. On the inner face of the bottle, there is compression over the mid portion of the panel, and tension near the corners. This tension is twice as great as the tension on the outside, and theoretically the bottle should split up the corners as an inside break. But in practice, the inside of the bottle does not get so scuffed and scarred as the outer face, and the bottle breaks on the outer face and somewhere near the middle of a panel. It may be shown that this central tension on the outside is given by

$$f_2 = pd^2/4s^2$$

The total tension is obtained by adding f_1 and f_2, whereon we get

$$f = p(\tfrac{1}{2}q + \tfrac{1}{4}q^2)$$

where q is the ratio d/s

The first term is the term appropriate to a round bottle. The second term is to be added if the bottle is strictly square.

If q is about 25 or 30, ½q is 12 to 15, while ¼q^2 is 150 to 200, that is, some 12 or 15 times as great.

It would seem to follow that thin-walled square bottles may have only one-tenth or less of the strength of a round bottle of equal wall thickness. In practice we hardly run into such extreme conditions, for two reasons:

(1) Round bottles are never perfectly round, nor of perfectly even wall thickness. Thus their strength is considerably less than one would expect.

(2) Square bottles are never perfectly square, but tend to be designed as a compromise between a square and a round. Also they are not, as a rule, sufficiently tall but that some support is given by the base and shoulders of the bottle.

Thus the difference in strength between nominally round and nominally square bottles, while very serious, is distinctly less than the theoretical figures.

For instance:

Figure 4 shows a "square" jar in section, and it will be obvious that it is a hybrid between a circle and a square. To a first approximation the shape is given (in polar coordinates) by $r = a = b \cos 2\theta$ while $q = 32$.

Figure 5 shows an elliptical bottle, whose equation approximates to

$$r = a = b \cos \theta \text{ while } q = 29.$$

Figure 3 shows a nominally circular bottle,

$$r = a \text{ and } q = 31$$

The circular bottles had an average pressure strength of 225 lb./sq. in.

The elliptical bottles had an average pressure strength of 100 lb./sq. in.

The "square" bottles had an average pressure strength of 55 lb./sq. in.

all on a 1 minute sustained pressure test.

Certain bottles more nearly square, but with much thicker walls (lower value of q) give values around 20 lb./sq. in.

It would seem to follow that bottles in which the square shape is avoided by a substantial margin (Figure 4) are a great deal stronger than one might expect, though they are only about one-fourth the strength of comparable

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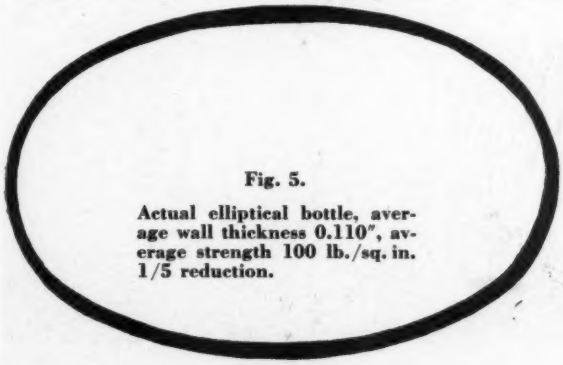


Fig. 5.

Actual elliptical bottle, average wall thickness 0.110″, average strength 100 lb./sq. in. 1/5 reduction.

Fig. 4.

Actual "square" bottle, much compromised towards circularity. Wall thickness 0.110″, average strength 55 lb./sq. in. 1/5 reduction.

URBANA CONFERENCE ON GLASS PROBLEMS

After a lapse of two years another Conference on Glass Problems, the sixth of the series, was held at the University of Illinois on May 10th and 11th. It was devoted to the consideration of some practical aspects of glass manufacture.

That a forum for the discussion of practical problems in glass manufacture commands widespread interest among plant operators and engineers was again in evidence at the Sixth Conference on Glass Problems, held at the University of Illinois on Friday and Saturday, May 10th and 11th. For this meeting, eighty-five men interested in the business of glass making visited the university, greeted the speakers warmly, entered enthusiastically into the discussions, enjoyed the entertainment features and renewed old friendships. This conference added another to the unbroken list of successful meetings at Urbana and emphasized the desirability of this type of gathering at regular intervals.

Although it was, as usual, stated rather impersonally that the conference was under the auspices of the Department of Ceramic Engineering of the University of Illinois and the Chicago Section of the American Ceramic Society, the successful planning and execution of the program represented, as usual, the personal achievement of Prof. C. W. Parmelee and a few of his staff members, aided and abetted by G. G. Hanson of Chicago. To this small group of enterprising individuals the glass industry owes a real debt that was scarcely repaid by the rising vote of thanks at the end of the session. The best sort of recognition will be an increased interest and cooperation in future programs from practical glass plant men throughout the country.

In opening the conference session on Friday afternoon, Dean M. L. Enger of the College of Engineering welcomed the visitors and expressed the official pleasure of the University at the encouraging number in attendance. He also spoke of the valuable information offered to industrialists by the Engineering Experiment Station at the University. Professor Parmelee described the interesting researches in glass conducted in his own department of Ceramic Engineering during the past couple of years. These projects have included investigations by members of the staff, together with theses assigned to undergraduate and gradute students and directed by staff members.

The next speaker was R. L. Shute, a member of the Department of Ceramic Engineering at Urbana and a practical glass man who has become increasingty well-known during recent years through his published articles and scientific society papers. Mr. Shute mentioned the current applications of batch briquetting methods and described his own experiments with different binders for various types of batch. He then suggested a mixing and drying operation for batch with a binder, although he concluded that present briquetting methods would be somewhat less expensive.

The much-discussed Seagram specifications next received attention in a paper by A. Herman of the Seagram organization. Mr. Herman turned out to be a speaker of rare charm as he described the difficulties of the distillers with bottles of low chemical durability, outlined the present tests and specifications, and solicited the cooperation of glass men in further efforts to solve the problem. Samples of deteriorated liquors were passed around for looking but no quaffing.

Use of the employee's suggestion box has been tried

Conferees at the Sixth Conference on Glass Problems, held at Urbana, Illinois last month.

with more or less success in a great many industrial plants. The successful utilization of the employee suggestion plan in a glass factory was described in detail by J. N. Martin of Pitney Glass Works, General Electric Co., his paper indicating that psychological factors in any scheme are of major importance.

Dr. A. E. Badger then closed the Friday afternoon session with a resume of recent technical and engineering advances in the industry as revealed in the technical literature. Dr. Badger's discussion was illustrated by charts, tables and pictures from various publications and covered practically every phase of glass manufacture.

After an informal dinner at the Men's University Club, enlivened by Ross Purdy's quips and W. F. Curtis' broad smiles, the group was given a rare treat that entertained everybody and left the amateur photographers filled with envy. This occasion was the showing of a big reel of movies, entitled "Science in Nature" and taken by C. F. Hottes, Professor-Emeritus of Plant Physiology at the University.

With G. G. Hanson as chairman, the Saturday morning session opened with a discussion of the troubles incident to the Monday morning start-up, led by W. J. Mathews. Mr. Mathews raised a number of questions relative to melting tank conditions during and after a week-end shutdown, but from the ensuing discussion it was apparent that there is very little uniformity in methods of tank operation during low production periods.

One of the most interesting and informative papers of the conference was given by I. G. Fowler of the Libbey-Owens-Ford Glass Co., who described and evaluated the system of automatic pressure and combustion control now in use on the plate-glass tank at Ottawa. The adaptation of modern forms of control apparatus to glass furnaces is of real importance to the industry, as was immediately evidenced by the lively discussion which followed Mr. Fowler's paper. Glass men are awake to the possible economies to be derived from proper instrumentation of heating devices and this paper furnished the sort of practical information that is needed for further advances in technique.

During the past few years the Department of Metallurgy at the University of Illinois has conducted an almost continuous investigation of cast-iron moulds for glassware, the work being under the direction of Prof. W. H. Bruckner. A progress report on this endeavor was given by Prof. T. J. L. Walker, due to the illness of Professor Bruckner, the report confirming known characteristics of glass mould irons and pointing out further objectives for the research program. An interesting finding has been the presence of a material in glass mould cracks, the composition of which is as yet unknown but which demands further investigation for a better knowledge of the initiation and propagation of such cracks.

The last item of the conference program was an exposition of the manufacture and uses of modern plastics, given by F. W. Warner of the General Electric Co.

Summaries of Papers

Departmental Researches in Glass. *By C. W. Parmelee, Head, Department of Ceramic Engineering, University of Illinois.*

A total of eighteen problems are being or have been studied in the department during the past two years, this work being carried on by staff members or assigned for thesis investigation to undergraduate and graduate students. Studies of the physical properties of glass have included an investigation of tensile strength, a method of measuring the density of molten glass and thermal expansion examinations of several glasses. An investigation of electrical resistance at 400 deg. C. and dielectric losses at high frequencies for 29 glasses was reported at the recent meeting of the American Ceramic Society.

There has been much activity in the investigation of the chemical properties of glass. In the study of a method for testing the chemical properties, important conclusions have been reached concerning the preparation of the sample and the amounts of soluble material extracted. It has been shown that fluorspar facilitates the melting and fining of glass batches and a series of new glasses, formed by substitutions of lithia for varying amounts of soda, have been examined for physical and optical properties. In the study of titania-alumina-silica and zirconia-alumina-silica glasses, it was found that both series devitrify readily and some glasses with low thermal expansion were prepared. Reactions between 27 metals and molten glass were investigated and studies of gold-ruby and vanadium-oxide glasses have been made. For a senior thesis valuable information has been accumulated bearing upon the relation between composition and the "fading" of glass upon exposure to sunlight.

In the field of glass melting operations, a thesis summarizes recent developments in glass furnace design and operation. The relation between heat penetration during melting and the color of molten glass has been studied. The use of blast-furnace slag in glass batches has been reported and a new method for binding glass batch is covered by a paper at this meeting. Use of caustic alkali as a batch constituent has also been tried and discussed in the techincal press.

Methods of Binding Glass Batch. *By R. L. Shute, Department of Ceramic Engineering, University of Illinois.*

In the quest for batch preparation methods which would eliminate dusting and the segregation of materials the briquetting of the batch seems to be the most complete answer to the problem, but the only factories now using briquetted batch are the plants of the Ford Motor Co. at Dearborn and St. Paul and the Sneath Glass Co. of Hartford City, Indiana. In all of these installations the dry batch is moistened with sodium silicate in a mixer, delivered directly to a briquetting press, and then dried for 10 or 15 minutes before use. The expense of the process has probably been a major factor retarding more general use of briquetting.

As a binder for the batch, alternatives to sodium silicate are organic materials, such as the starches or dextrins, and inorganic materials such as Portland cement or asphalt. Corn starch has fair adhesive power when dried at temperatures around 300 deg. F., but is not equal to sodium silicate. Portland cement produced better results, but required several hours to reach maximum hardness. Both materials are more expensive than sodium silicate.

It was found that random fragments or lumps of batch which were simply mixed with sodum silicate and allowed to dry were firm enough to withstand rough handling. A series of experiments were performed to determine the minimum amount of sodium silicate and water necessary to form firm lumps of batch, and the time and temperature required to dry them. Three kinds of batch were studied, having powdered limestone, crushed limestone and burned lime, respectively. It was found that lumps bonded with the weaker solutjons crumbled more, but when the concentration ot sodium silicate in the binder reached about 20 per cent spalling occurred in drying.

The success of the mixing-drying process depends upon a cheap and plentiful source of heat for drying, but it was determined that sufficient heat is available in the combustion products from a glass furnace to dry its own batch. A practical method for mixing-drying would be to pass the mixed dry batch through a wet mixer in which the binder solution is added. The wet batch would then enter a special type of feeder and finally the lumps would be delivered to the wire mesh belt of a drying oven. A summary of the results of calculations to show cost comparisons between the

use of dry batch, briquetted batch and mixed-and-dried batch is given in the following table:

	per day
1. *SAVINGS*	
Raw material carried over into checkers	$ 9.00
Saving in depreciation of checker brick	10.00
Saving in depreciation on balance of furnace	20.00
Total daily saving, approximately	$39.00
2. *INCREASED COST OF OPERATION FROM USING BRIQUETTING PROCESS*	
Sodium silicate to treat batch: 80 tons at $.31 per ton	$25.00
Power: 1200 K.W. per hour at $0.008 per K.W.H.	9.60
Operating labor: 4 men at $5.00 each per day	20.00
Interest on investment: $8,500.00 at 4 per cent per year	1.00
Depreciation: at 10 per cent per year	2.40
Maintenance: at 10 per cent per year	2.40
Increase in operating cost, approximately	$60.40
3. *INCREASED COST OF OPERATION FROM USING MIXING AND DRYING PROCESS*	
Sodium silicate to treat batch: 80 tons at $.46 per ton	$36.80
Power: 1200 K.W. per hour at $0.008 per K.W.H.	9.60
Operating labor: 4 men at $5.00 each per day	20.00
Interest on investment: $11,000.00 at 4 per cent per year	1.25
Depreciation: at 10 per cent per year	3.30
Maintenance: at 10 per cent per year	3.30
Total daily cost, approximately	$74.25
4. *INCREASED COST OF OPERATION OVER DIRECT SAVING EFFECTED*	
Briquetting process (Limestone Batch)	$21.40
Mixing and Drying Process (Crushed Limestone)	35.25
Mixing and Drying Process (Powdered Limestone)	27.25
Mixing and Drying Process (Burned Lime)	24.05

From these figures it is evident that the increase in operating cost for either of the binder methods is considerably in excess of the direct savings and their installation can be justified only on the score of possible fuel savings, improvement in quality or increased output. It is also apparent that the mixing-drying method is more costly than the briquetting process, but this might be reversed in the case of a smaller furnace.

Discussion: In response to a question by A. B. Scholes regarding the use of clay as a binder, the author stated clay had been tried in combination with starch and that a higher alumina content in the glass resulted. F. G. Schwalbe asked if any comparison between the melting rates of dry and briquetted batch had been made and said that one user of briquetted batch had noted an increase of about 30 per cent in the melting rate. Mr. Schute replied that no such comparisons had been made in this series of experiments.

Floyd Pruden of the Sneath Glass Co. stated that their briquetting work was still in the experimental stage. Mr. Shute then inquired if anyone had any information about the extrusion method for pressing batch into lumps. Mr. Schwalbe stated that experiments with this method produced pieces or lumps which differed greatly in size and shape and presented a difficult conveying problem. L. G. Love asked about the use of hydrated lime as a binder and the author replied that it had been tried at the Ford Motor plant in St. Paul, but the briquettes soon returned to batch form and the sodium silicate binder is now being used.

Chemical Durability of Glassware from the Distiller's Standpoint. *By A. Herman, Joseph E. Seagram & Sons, Inc., Louisville, Kentucky.*

When thousands of cases of gin with a slight turbidity and a faint bluish color were returned to one of the Canadian plants of the Seagram company in 1929, it was observed that the pH of the gin was higher and the titrable acidity lower than usual. Distilled gin normally contains a very small amount of weak organic acid and very little base would be necessary to neutralize it, so it was suspected that the change in pH might have something to do with the turbidity. After several months of discussion with the glass companies without definite conclusions, the problem was referred to Dr. W. E. S. Turner, of Sheffield University, England. He found that glass containers had a definite effect on gins and whiskies.

The next problem was to find control procedures and to set specifications, but nothing suitable was found in the literature. However, the so-called "powder method" was obtained from a well-known American glass company and this method was used to test sample bottles. The Canadian glass companies cooperated in the work and within a year the alkalinity of Seagram bottles, as indicated by the powder test, dropped 50 per cent. When the company started operations in the United States in 1933, the glass suppliers were notified that the alkalinity of the bottles would eventually be specified and they were supplied with all the data collected up to that time.

It had been evident for some time that the powder method was not entirely satisfactory, since it was time-consuming, it was difficult to prepare the samples, results were not completely reliable, and finally it did not deal specifically with the inside of the bottle. Autoclave methods had been reported in the literature and a series of experiments were made which eventually developed the method now used. Bottles filled with pure distilled water are steamed at 15 lb. pressure for one hour and a 100 ml. aliquot is titrated with N/50 sulfuric acid, using methyl red indicator. Results are reported as ml. N/50 acid used per 100 ml. of solution and, while the method is not perfect, reproducible results can be obtained in the various Seagram laboratories. Having a fairly good method for checking alkalinity, the specification was arrived at by observing the point at which trouble had been experienced, as shown by the records. The purpose of the specification was only to get a finished glass container that would have no deleterious affect on Seagram products.

The acids contained in whiskies are weak organic acids which are only slightly ionized, even in water solution. While the pH of alcohol solutions is taken Seagram uses it only as a comparable value, because little is known about pH measurement in alcohol solutions or the interpretation of the readings. It was found that bottles contribute to the light-brown, flocculent precipitates that sometimes collects at the bottom of bottles of whiskey, and it was also observed that the ratio of volume to inside surface was a factor. These findings made necessary the specification of maximum limits for alkalinity in whiskey bottles as well as those for gin.

More work has been done in collaboration with independent laboratories to standardize the equipment, reagents and procedure. The distilled water must be pure, because small amounts of metals in the water have a decided effect on the results. Bottles were sent recently to fourteen different laboratories where they will be tested under identical procedure.

The responsibility for clouded gins and whiskies does not rest on the glass manufacturers alone, however, since other factors also contribute toward the formation of these precipitates. Among these are small amounts of heavy metals picked up in process.

Discussion: C. S. Boruff and D. Althausen, Hiram Walker & Sons, Inc., Peoria, Ill., presented a prepared discussion complimenting the Seagram company for its stimulative activity on the general problem of durability in liquor bottles and agreeing about the necessity for some recognized technique to gauge the suitability of the glass used. However, Messrs. Flint and Lyle have pointed out that "the numerous uses of glass and the variety of glass compositions make it impracticable to apply a single standard test in order to predict the chemical resistance of all shapes and compositions," and more recently, O. G. Burch has found that "there is no relation that holds for all glass bottle compositions between the tendency of a bottle to form flakes when filled with distilled water . . . and the amount of soluble material extracted from the glass surface," so caution must be used as regards the efficacy of any single test. Autoclave test values seem to have little assurance of performance if other factors are neglected, such as mould form, length of empty storage, effective acidity of alcoholic beverage, proof of bottled stock,

(*Continued on page* 288)

INVENTIONS AND INVENTORS

A Summary of United States Patents of Interest to the Glass Industry Issued During April.

Compositions

Patent 2,198,733, assigned by Edward C. Leibig of Wellsboro, Pa., and James F. Hyde of Corning, N. Y., to Corning Glass Works, indicates that these inventors have successfully electrolyzed glass and thereby replaced its alkali by copper, silver or another alkali metal. As shown by Fig. 1, a glass tube 13, to be treated, is immersed in a low melting salt such as cuprous chloride which is kept molten by a burner. The same liquid is contained in the tube. Conductor rods 15 and 16 of carbon carry a current to the molten cuprous chloride which is heated to a temperature between the strain point and the softening point of the glass. When 15 is the positive rod, the current is conducted by the copper ions to the inner wall of the tube with the result that copper ions penetrate the glass. Alkali ions emerge from the outside wall of the tube 13 and complete the circuit to the negative carbon carbon pole 16.

By these methods the borosilicate glass shown below as A, was changed to the analysis B by using cuprous chloride and to analysis C by using silver chloride. The characteristics of these glasses were such as to show that these compositions could not have been fabricated by melting methods.

	A	*B*	*C*
	Per cent	*Per cent*	*Per cent*
Silica (SiO_2)	80.6	76.5	72.1
Soda (Na_2O)	4.3	.1	
Potash (K_2O)	.1	.1	.4
R_2O_3	2.0	1.9	2.1
Boric Oxide (B_2O_3)	12.9	12.2	11.9
Copper oxide (Cu_2O)	...	9.0	...
Silver oxide (Ag_2O)	...	...	13.3

The claims, and presumably the method, are limited to the use of replacing metals from the first group in the periodic table.

Furnaces

Albert T. Underwood of Hartford-Empire Company patented an improvement in air cooling for the side wall of a glass tank at the metal line (2,199,355). The aim was to eliminate the day-by-day variation in cooling effect due to weather changes and other causes. The apparatus provides a continuous measurement of the temperature at a point near the application of the cooling blast, and means whereby these measurements control the temperature of the blast.

A novel method to keep the glass circulating in a forehearth is covered by patent 2,198,304, assigned by Anders E. A. S. Cornelius, of Baltimore, to the Crown Cork & Seal Company. Instead of using a mechanical agitating element, it is proposed to bring about agitation of the molten glass by electro-magnetic forces produced by a changing or shifting power field generated within a stator device. As shown in Fig. 2, the forehearth is built in circular form. A stator frame 29, carries a series of poles 32 energized by exciter coils 32a. It is explained that this stator assembly is similar in principle to the stator of an A.C. motor, and that the molten glass in the hearth is analagous to the closed-circuited rotor or armature. It is stated that the rapid rotation of the A.C. field will impose "marginal rotary impulse" upon the glass resulting in relatively slow motion, sufficient to obtain the gentle agitating effects needed. In the particular modification shown, other features are a conductor disc 50 floating in a body of liquid metal 49, both being in contact with the molten glass and tending to impart motion to the glass by frictional contact.

Feeding, Forming and Shaping

Crown Cork & Seal Co. received three machine patents through assignment by the inventors. T. F. Pearson of Pontefract, England, patented a clutch assembly for driving glass machines, 2,197,436. Samuel E. Winder, of Baltimore, received patent 2,198,750 for a forming machine designed to completely form an article of glassware in a single mold, thus dispensing with the conventional parison or blank molds. Patent 2,198,741 issued to Niels R. Salskov-Iversen of Baltimore introduces what is described as a radical departure from standard gob feeding practices. Other gob feeders are said to employ some means for increasing the pressure on the glass above a stationary orifice to increase the speed of movement of

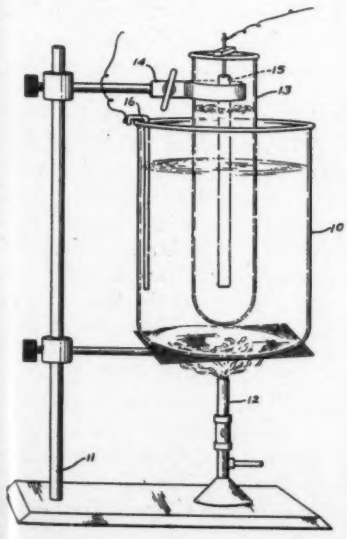


Fig. 1 (Left)

2,198,733: Leibig and Hyde. Replacement of alkalies in glass by electrolysis.

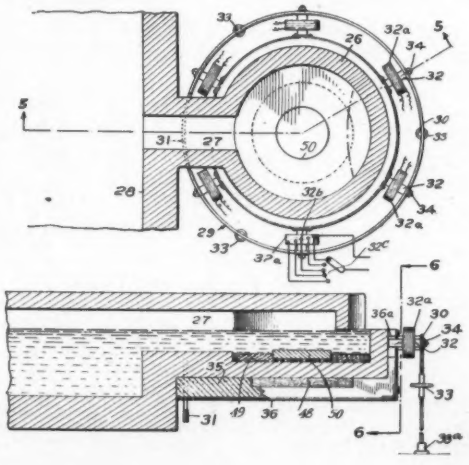


Fig. 2 (Right)

2,198,304: Cornelius. Glass circulation in forehearth induced by electro - magnetic forces.

the glass during the formation of the gob. The Salskov-Iversen patent utilizes the inherent inertia factor of the glass in forming mold charges, as is best understood by referring to Fig. 3. The charging tube 18 is moved upward or downward by a driving mechanism. The tube is flanged at 19 to effect a seal with a bath of molten metal 17 contained in a circular basin. The refractory plug 22 is to be used only if needed. The tube filled with molten glass moves downward until reversal occurs. When the tube is moved upwards inertia causes the column of glass to remain relatively stationary so that the lower end of the column is exposed for shearing.

In a tube-making apparatus, Wm. H. Smith of Corning, N. Y. (2,198,741 to Corning Glass Works) produces an enlarged bore in a mass of plastic glass, chills the wall enough to make the tube self-sustaining, forces a reduction in bore to the exact size desired as the wall is softened sufficiently by heat from the surrounding plastic mass, and then cools the tube to retain the desired size permanently.

Karl E. Peiler of West Hartford, Conn., patented a suction glass feeding apparatus (2,199,140) which he assigned to Hartford-Empire. He states that the usual intimate contact of the glass with the gathering device has disadvantages principally in the chilling of the glass. His invention provides for opening slightly the half sections of the suction cup before delivering the glass charge, so as to disturb the intimate contact of the glass with the walls of the cup.

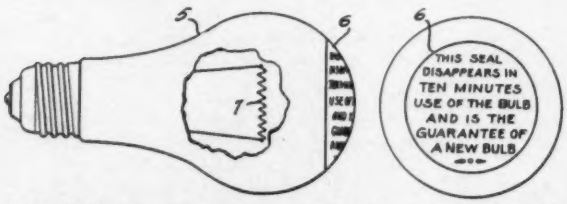
Alvin E. Brown of Muncie (Owens-Illinois) has patented a molding apparatus for glass blocks which provides, among other things, for the mold charges to be turned over upon arrival at the mold. Otherwise, the face of the charge which had been slightly cooled by the delivery device would be the portion placed next to the molding surface. (2,199,356).

A method and machine for forming ampoules was patented by Jakob Dichter, Berlin-Schoneberg-Germany, (2,199,332).

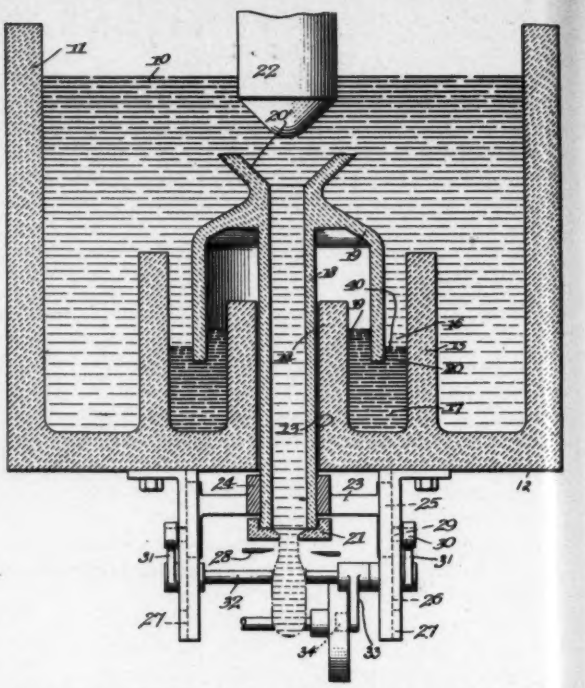
Decoration

Fig. 4 shows a novel identifying mark which may be applied to light bulbs, domestic irons, or many other electric heating devices. The inventor, Willard F. Greenwald of New York City (patent 2,198,162 assigned to General Electric Company), intends to protect the consumer against the purchase of used products as new ones, by marking new articles with suitable lettering which will disappear when the article has been heated for a brief period. Examples of suitable printing agents are given in the patent.

Harold R. Schutz and Lawrence O. Mankin of Toledo, assigned to Libbey Glass Co., their patent 2,198,565 for a tumbler decorating machine which is fully automatic.



2,198,162: Greenwald. A manufacturer's seal printed with ink which disappears permanently when the article has been heated briefly.



2,198,742: Salskov-Iversen. The gob is formed by the inertia of the glass column which keeps it from returning to the tank when the feeder tube 18 is drawn upward.

Mr. Schutz collaborated with Edward H. Bennett, also of Toledo (and Libbey Glass Co.) in patenting (2,196,094) another apparatus for applying colored bands to plates, saucers, etc.

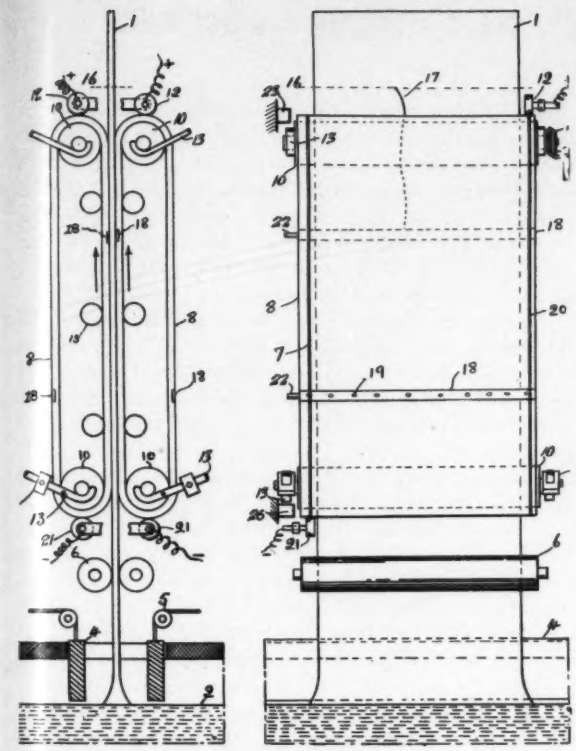
Miscellaneous Processes

To overcome the lehr-developed white haze or blown on the surface of glass ware, Rowland D. Smith proposes to keep the conveyor belt wet with a sulphur absorbing solution (2,198,745 to Corning Glass Works). He states that the sulphurous gases in the combustion gases which cause the bloom can be absorbed by "an alkaline reacting compound of an alkali metal such as sodium carbonate, or of an alkaline earth metal whose sulphate is soluble in water, such as magnesium oxide.

Another Corning Glass patent is 2,198,749 granted to Arthur W. Weber of Pawtucket, R. I., which relates to timing mechanisms for carrying out certain tempering operations.

Orie Shackelford of Fairmont, W. Va., patented a novel annealing lehr (2,197,440), made of a number of different sections linked together, but pivoted so that their relative angles of inclination could be changed. The general characteristics of the lehr are indicated by Fig. 5. The hot end of the lehr is at a higher level than the cold end and the intermediate sections are mounted for adjustment at desired levels to control the flow of convection currents. Further flexibility to aid in controlling the temperature curve is obtained by movable roof sections to allow escape of air to the outside of the lehr.

In a furnace for heating glass sheets for tempering, Robert S. Hinsey of Toledo, has devised an automatic closure for the slot in the furnace roof through which the sheet suspending tongs are moved. The slot is opened and closed by two continuous rows of molded asbestos



2,197,811: Spinasse. Heating elements 18 on the belts directing newly-drawn glass sheets prevent cracks 17 from traveling downward.

fingers, which meet in the center of the slot. They are bevelled so that the tong carrier pushes them aside in a manner not unlike the opening of a zipper by its fastener. The fingers fall back into place as the carrier passes and keep the slot closed to prevent heat loss and drafts. This is patent 2,197,550, assigned to Libbey-Owens-Ford.

In a further development of the tempering art, Charles J. Phillips of Corning Glass Works (2,198,739), proposes to heat glassware in the usual way and then to temper it by chilling in a liquid having heat transfer characteristics intermediate between water and heavy oils. Such a liquid is 1:2:4 trichlorbenzine.

Frank Redman of Washington, Pa., was granted patent 2,198,740, assigned to Hazel-Atlas, for apparatus for assembling the parts of closure clamping devices. Anchor-Hocking Glass Co. was assignee of patent 2,198,589 issued to Wm. D. Bell of Columbus, Ohio, for apparatus for sealing containers.

Charles F. Schmidt of Toledo, assigned to Owens-Illinois Glass Co., his patent 2,197,714 for an apparatus for assembling glass applicator rods and bottle caps.

Harry D. Madden of South Orange, N. J., patented a machine and method for sealing light bulbs, 2,197,527, which he assigned to Westinghouse Electric & Manufacturing Co. By this method, the exhaust tubes of bulbs filled to a superatmospheric pressure, partly enclosed in a chamber also carried at pressures higher than atmospheric, are heated and twisted to cause the tube to collapse for tipping-off purposes.

A glass-to-metal seal was patented by Lynn Goodale of Newark, N. J., who assigned the patent 2,198,769 to Federal Telegraph Co. of that city. A machine for making glass-to-metal seals, patented by A. J. Franke of Harrison, N. J., was assigned to Radio Corporation of America (2,195,483).

Patent 2,199,087 will be of at least casual interest to glass fiber workers since it is concerned with means for applying binding materials to mineral wool at the point of formation. This patent was assigned to American Rock Wool Corp. by D. C. Drill, C. L. Whitenock and J. H. Gregory.

Plate and Sheet Glass

James H. Griffin of St. Helens, England, obtained a patent on a modified procedure for polishing traveling flat glass. (Patent 2,197,104, to Pilkington Bros., Ltd., Liverpool, England). It is stated that the method of polishing both sides simultaneously produces over-heating which may cause the glass to crack. The Griffin invention provides two groups of polishing tools, one above and one below the glass strip, but offset from each other. The strip is supported opposite the polishing tools by roller beds.

Patent 2,197,811 granted to Arthur E. Spinasse of Mount Vernon, Ohio, discloses a method of retarding the cracks which may form in a glass sheet as it is being

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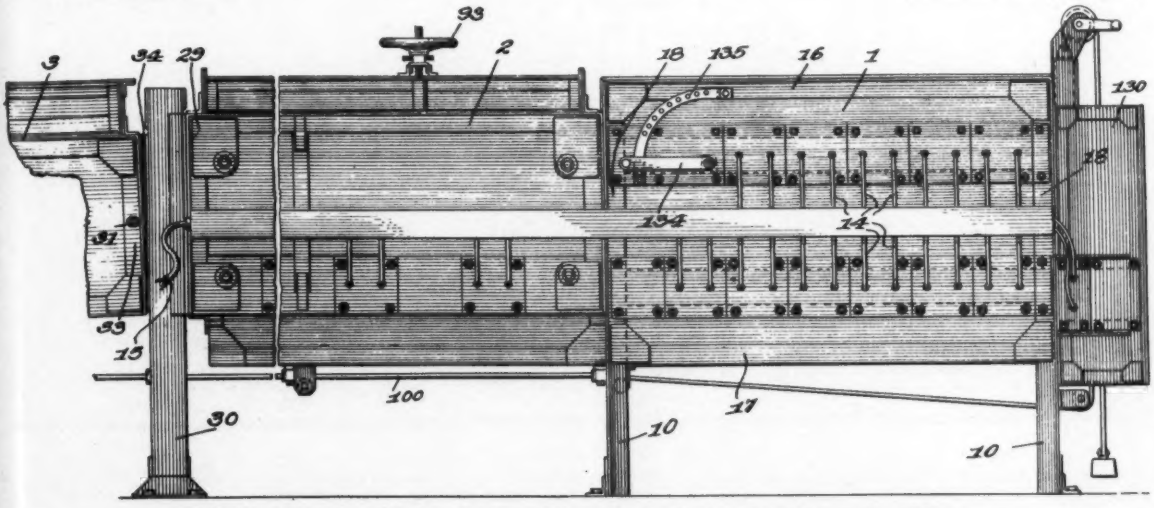


2,197,440: Shackelford. Sectional lehr with level of each section adjustable.

G. C. A. MEETS AT WHITE SULPHUR SPRINGS

War clouds from across the Atlantic cast their shadows over White Sulphur Springs during the annual meeting of the Glass Container Association on May 20, and no doubt their sobering influence helped to grey the background of this colorful convention. Although behind the industry there is a record of achievement this past year that might have been utilized as a nucleus of a self-congratulatory program, officials and speakers seemed willing to ignore these and instead to concentrate upon the problems and the difficulties. Here there was a frankness and candor, a willingness to face unpalatable realities that seemed peculiarly attuned to the tempo of the hour.

Production and Shipments

The active productive capacity of the glass container industry has increased from 57,000,000 gross in 1929 to 81,000,000 gross in 1939, or 41 per cent. For this three factors are responsible: (1) *Increased furnace efficiency.* Although the number of active furnaces has decreased from 192 in 1928 to 174 at the present time, their melting efficiency has increased over 33 per cent, due to technological advances. Whereas 12 years ago, it required 12 sq. ft. of furnace area to melt a ton of glass, to the day the gauge is approximately 8 per cent, and a few plants have done it under 6 sq. ft. (2) *Modernization of Mechanization.* In 1928 the container industry had just become mechanized. This mechanization, however, was a far cry from the perfection since attained in forming and lehr equipment; in materials handling, instrumentation and other improved factory processes and methods. (3) *Light-weight containers.* Today, a substantial portion of container tonnage is in the light-weight class. This means that a given weight of melted glass will produce more finished containers than formerly. For example, the average weight of General Line containers in 1929 was 86.6 lbs. per gross; in 1935, 91 lbs.; in 1939, 86 lbs. Milk, fruit and jelly glasses averaged 174 lbs. in 1929; in 1939, 152 lbs.

Shipments — the industry's sales volume — have increased 46 per cent during this period. While at first glance, this percentage increase compares favorably with the 41 per cent increase in productive capacity, one must look back to the shipment to capacity ratio at the beginning of the period to understand the picture correctly. In 1929, operations were at 59 per cent of capacity, and by 1932 they had dropped to 46 per cent. The curve then ascends until it reaches its most favorable level in 1937, or 70 per cent of capacity. Today, with actual tonnage approximately the same as 1937, the ratio to capacity has fallen to 60.7 per cent, which is practically the same as 1929. This is an unhealthy situation. It means that the industry must either expand its market, or it will become competitive to an unwholesome degree.

Fig. 2 shows a very interesting relationship between the shipments of the different divisions of the industry. The first group of bars is a composite of all the food containers: narrow neck, wide mouth and pressed ware. The re-use group includes beer, pressure and non-pressure ware, milks, fruit jars and jelly glasses. The other lines are represented as distinct classes. In each group, the first bar represents the total volume of shipments for

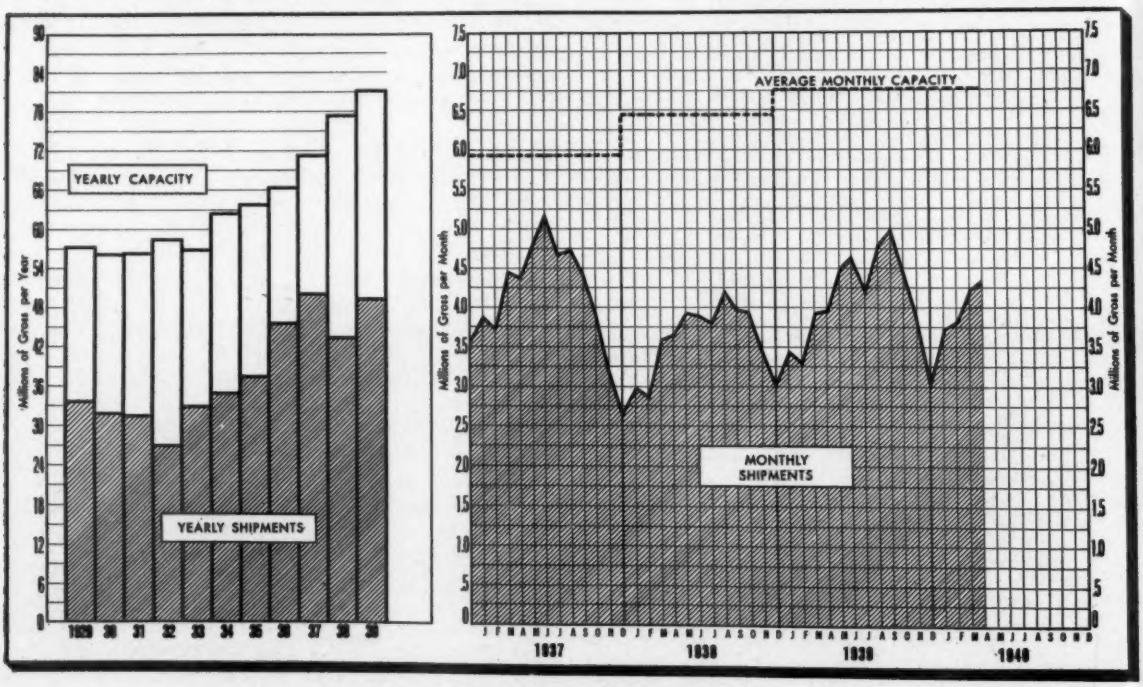


FIG. 1. Shipments Compared to Capacity

Bars on the left show the relation of total annual shipments (shaded area) to capacity (entire area). To the right is shown monthly variations in shipments since 1937. The trend from month to month follows the general trend of business very closely.

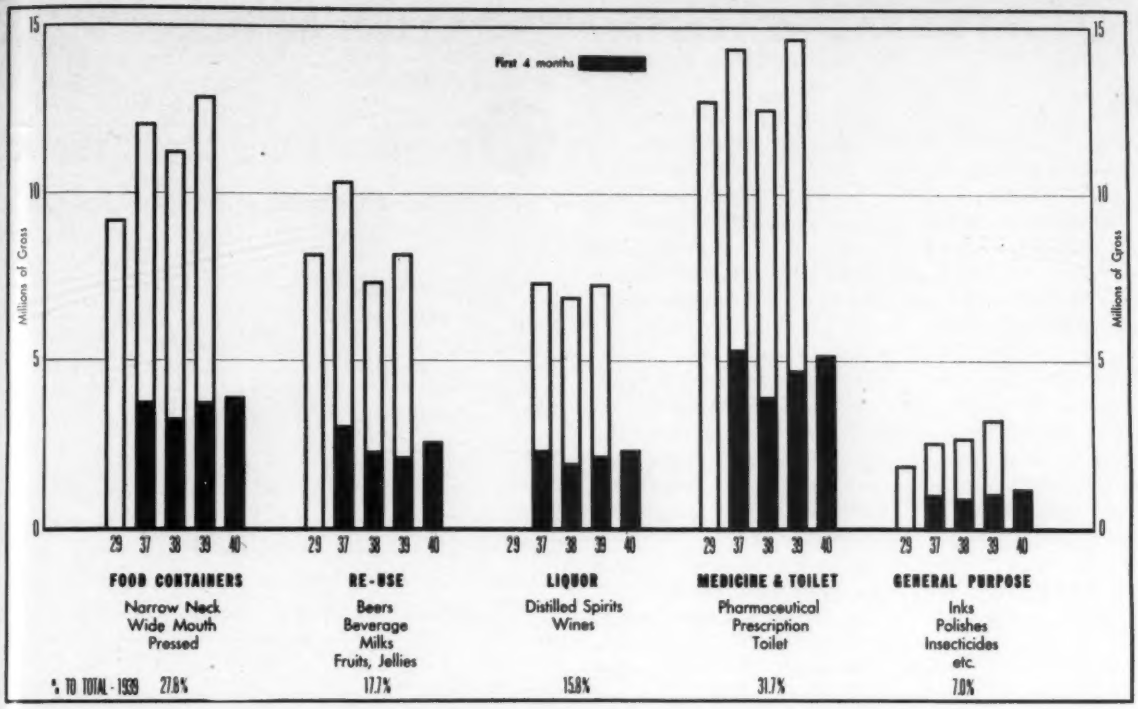


FIG. 2. Relative Production of Different Types of Containers

The complete bar represents total annual production; the black area, the first four months. Next to Liquor-ware, which was not made in 1929, the miscellaneous or General Purpose group has shown the largest gain since 1929, with Food and Medicine next in that order.

1929, followed by 1937, 1938 and 1938. The black area in each bar represents the first four months of those years, including 1940.

The relative importance that each division bears to the total of all kinds of containers is exemplified for the year 1939 as follows:

Food Containers	27.8%
Re-Use Containers	17.7%
Liquor Ware	15.8%
Medicinal and Toilet	31.7%
General Purposes	7.0%

Food containers have shown a steady and substantial growth since 1929, as Fig. 2 indicates. Last year the volume was 40.5 per cent greater than in 1929 and 6.8 per cent ahead of 1937.

Re-Use containers have the same volume as in 1929. The new beer volume has offset the shrinkage in beverage, milks and fruit jars. It is to be noted that the re-use container is the most economical for the user, the economy being derived from the fact they make many trips for their owners. This group has been the object of the most bitter attacks by competitive types of containers.

Liquor and wine containers are all new since 1929. It represented 15.8 per cent of last years volume and accounted for 50 per cent of the total gains made over the past 11 years.

The Medicinal and Toilet group includes pharmaceuticals, presecription bottles and all types of cosmetic and toilet ware. It shows a gain of 14.5 per cent in 1939 over 1929.

General Purpose ware includes all unclassifiable items, such as inks, polishes, insecticides, paints, etc. This has shown the greatest gains of any group since 1929; namely, 72.7 per cent, and this reflects the consatntly growing use of glass containers for products heretofore packaged in other types of containers.

First quarter shipments for 1940 show a continuation of the increases registered last year. The following table shows how these gains have been distributed:

Food Containers	3.99%
Re-Use Containers	21.11%
Liquid Ware	7.46%
Medicinal and Toilet Ware	9.81%
General Purpose	13.17%
Total Industry	10.98%

The Laboratories Program

The Association continues to retain the services of the Preston Laboratories at Butler, Pa. Briefly summarized, the work of these laboratories has been mainly: (1) Examining bottles involved in lawsuits. Out of 14 suits, only one came to trial and this was successfully defended. (2) Making strength tests and analyzing breakage of test bottles sent in by members of the Association. (3) Testing the effect of colored decoration on the strength of bottles. The report of this work will not be available until late 1940. (4) A study of internal scratching, including the result of using different metals, different detergents. This work has been completed for the most part. (5) Comparative tests of glass and tin containers for the packaging of combustible liquids. Results show that when venting caps are used, glass presents no greater fire hazard than tin, and in some respects seems quite superior. (6) Studying the effect of design on container strength, as for example the tapered base. (7) A study of cord. (*Turn to page* 286)

CURRENT STATISTICAL POSITION OF GLASS

During April the glass industry experienced a general sidewise movement, with production, employment and payrolls remaining at approximately the previous month's level. According to Glass Industry's Production Index output about equalled the previous month's volume of $29,500,000. This was 25 per cent ahead of April of last year. Production totals for the first four months indicate that 1940 is proving the greatest year in the history of this industry.

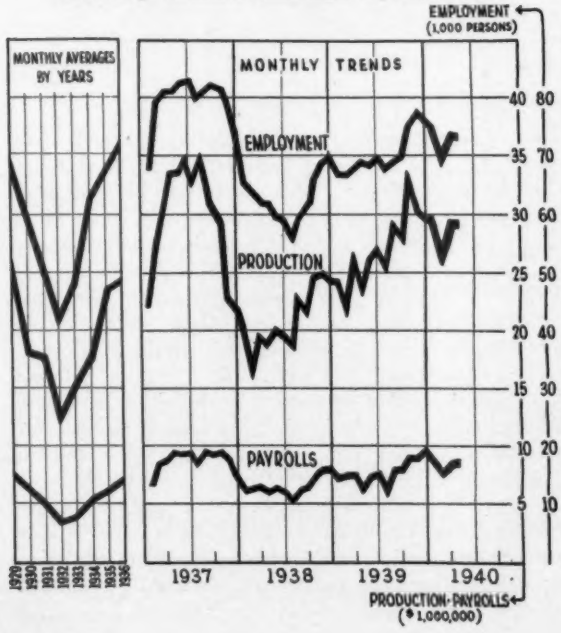
Plate glass production during April totalled 12,366,550 square feet, according to the Plate Glass Manufacturers Association. This was a decrease of 14 per cent from the previous month but was 70 per cent greater than April of last year. During the first four months of 1940 this output amounted to 57,101,100 square feet which was 38 per cent ahead of last year.

Window glass output during April amounted to 1,023,-465 boxes, which was a decline of 8 per cent from March, but was 38 per cent ahead of April 1939. Production during the January-April period totalled 4,643,495 boxes, as compared to 3,404,021 boxes during last years comparable months. These cumulative figures reveal that activity in this branch of the glass industry has been greater than in any rear since monthly statistics of the industry have been available (1937).

Glass container production during April totalled 4,584,398 gross according to the Glass Container Association. This was only 1 per cent less than March's figure, but was 13 per cent more than April of 1939. Output during the first four months of this year was reported to be 17,576,460 gross—16 per cent above last year's level and an all-time record for this period of the year. Shipments during April amounted to 4,339,-246 gross, which was 3 per cent greater than in the previous month and 9 per cent ahead of April of last year. Despite the decrease in production and increase in shipments, stocks on hand continued to climb, reaching another new record—10,233,568 gross. On a four month basis, 1940's shipments increased 9.7 per cent over the previous year's comparable volume to 16,124,085 gross; this was within 2 per cent of the industry's record figure (1937).

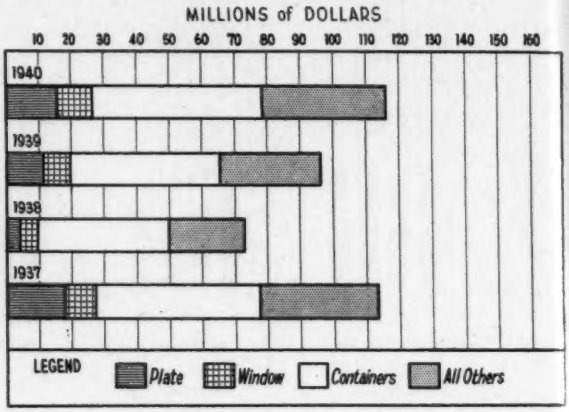
THE GLASS INDUSTRY'S INDEX

Monthly Trends Through April, 1940



THE GLASS INDUSTRY'S INDEX

Production for Four Months, January Thru April



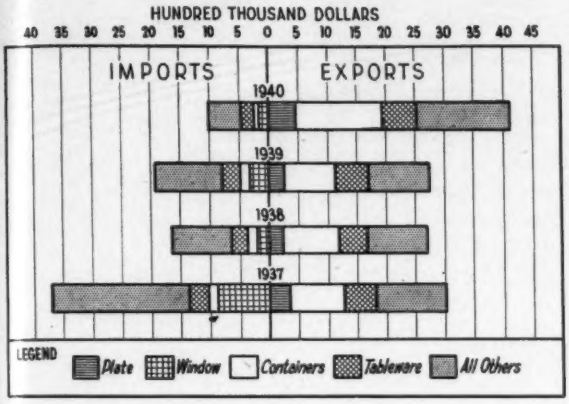
Miscellaneous glass products manufactured during April were valued at about $9,500,000 according to reliable estimates. This was an increase of 5 per cent over March but was 25 per cent more than April of last year. Stepped-up production of handmade tableware was the principal factor in the upward trend in this group. Illuminating ware sales were at about the March level and not more than 5 per cent ahead of April 1939. During the first four months of 1940 output of miscellaneous glassware was valued at approximately $36,000,000—15 per cent ahead of last year's comparable period.

Employment and Payrolls: Approximately 73,600 persons were employed in the glass industry during April. This was 400 less than in the previous month but was an increase of 5,300 or 8 per cent over April of last year. During the first four months of 1940 employment has averaged 73,300 persons as compared to 67,200 persons last year.

Payrolls in the glass industry totalled $8,400,000 during April which was a slight increase ($100,000) over March. This compares favorably with $6,900,000 in April of 1939. On the basis of January-April totals,

THE GLASS INDUSTRY'S INDEX

Foreign Trade for Four Months, January Through April



glass manufacturers have paid out $4,500,000 more in wages during 1940 than they did in 1939.

Foreign Trade: Exports of American glass products during April dropped 10 per cent below the previous month's level to $994,000. However, this was an increase of 38 per cent over the comparable month of 1939. Decreased sales were noted in all lines of glassware with the exception of illuminating articles. Combined totals for the January-April period exceeded $4,000,000—a 49 per cent increase over last year. Window glass sales were up 425 per cent, containers 62 per cent, illuminating ware 58 per cent and tableware 36 per cent.

Imports also declined in April, dropping 15 per cent below March and 61 per cent under April of last year to $270,000. This was traceable to decreased purchases of containers and tableware. Window and illuminating glass importations remained at the previous month's level while plate glass shipments increased by 17 per cent. During the first four months of 1940 trade in foreign glass products was 46 per cent less than in 1939.

BOTTLES FOR INTERNAL PRESSURE

(*Continued from page* 273)

round bottles (Figure 3); elliptical bottles are perhaps half as strong as round ones; while close approximations to a square are perhaps one-tenth as strong.

The theory may be extended readily to octagonal bottles, such as catsup bottles; with increasing elements of uncertainty. On the other hand, the newer styles of siphon bottles, which externally are decagons, may be regarded as substantially circular. The internal face is, of course, a close approximation to a circle, and the panels of a decagon are unimportant influences where the side wall is of even moderate thickness.

In all considerations of strengths, it must be remembered that *design* is only one of the influences; the processes of manufacture, which affect the distribution of the glass or the evenness of the annealing, are another; the manufacture and the inspection alike affect the integrity of the outer surface, and this is a substantial factor. Only a very extensive series of tests could distinguish and separate the effect of design. But enough has been said to show that shape of itself is a very important matter, and the reasons for it.

A. W. WEBER RECEIVES FELLOWSHIP

Arthur W. Weber, assistant manager of the Wellsboro plant of the Corning Glass Works, has been awarded an Alfred P. Sloan Foundation Fellowship for a year of advanced study in economics and industrial administration at the Massachusetts Institute of Technology. Mr. Weber is one of 11 executives nominated by industries in all parts of the country who will return to their companies upon completion of the program.

The recipients, each of whom has had an average of eight years' industrial experience since graduation from a recognized engineering of scientific course, will spend the year in the department of business and engineering administration and in the department of economics and social science at the Institute.

• The date for the 1941 annual meeting of the American Ceramic Society has been definitely fixed for March 30 to April 5. Contracts have been let for space reservations with the leading Baltimore hotels.

UNITED STATES FOREIGN TRADE IN GLASS
(Values in Thousands of Dollars)

	1940			1939		Percentage Changes		
	April	March	First Four Months	April	First Four Months	March-April	April-April	First Four Months
EXPORTS								
Plate	59	92	425	57	278	—36	+ 4	+ 52
Window	12	26	63	3	12	—64	+300	+425
Containers	350	380	1415	230	871	— 8	+ 52	+ 62
Tableware	188	198	698	134	517	— 5	+ 40	+ 36
Illuminating Ware	62	55	220	34	139	+12	+ 82	+ 58
All Other	323	350	1269	260	924	— 8	+ 20	+ 37
Total	994	1101	4090	718	2741	—10	+ 38	+ 49
IMPORTS								
Plate	28	24	82	4	22	+17	+600	+273
Window	60	60	180	71	322	...	— 15	— 44
Containers	15	18	60	63	161	—17	— 77	— 63
Tableware	58	92	245	109	302	—37	— 47	— 19
Illuminating Ware	8	8	27	97	228	...	— 92	— 88
All Other	101	116	443	345	889	—13	— 70	— 50
Total	270	318	1037	689	1924	—15	— 61	— 46

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%. 99% through 200 mesh	ton	46.00	43.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$)	lb.	....	....
Granulated	In bags, lb.	.0215	.027 -.0295
Powdered	In bags, lb.	.024	.0295-.032
Boric acid (H_3BO_3) granulated	In bags, lb.	.048	.054 - .0565
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.0865-.0875	.0925
Synthetic (Artificial)	lb.	No supplies available.	
Feldspar—(published list prices)			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	30.00-31.00	....
In bags	ton	31.60-32.60	42.00-45.00
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.075	....
In 5 Ton lots	lb.	....	.08
Less than 5 Tons	lb.	....	.085
Lime—			
Hydrated ($Ca(OH)_2$-MgO) (in paper sacks)	ton	8.50	8.50
Burnt (CaO-MgO) ground, in bulk	ton	7.00	....
Burnt, ground, in paper sacks	ton	9.00	9.00
Burnt, ground, in 180 lb. drums	Per drum	1.60	1.70
Kiln Dried ($CaCO_3$-$MgCO_3$) 10x30 mesh	ton	1.75	....
Kiln Dried ($CaCO_3$-$MgCO_3$) 16x120 mesh	ton	1.75	....
Nepheline Syenite, f. o. b. shipping point	ton	12.50	14.50
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.065	.0675
Hydrated 80-85%	lb.	.055	.0575
Salt cake, glassmakers (Na_2SO_4)	ton	18.00-20.00	25.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb	.95	....
In barrels	Per 100 lb.	1.35	....
In bags	Per 100 lb.	1.10	....
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	Per 100 lb.	....	2.50-2.90
95% and 97%			
Bulk	Per 100 lb.	1.35	....
200 lb. bags		1.415	1.44
100 lb. bags		1.45	1.475

Special Materials

		Carlots	Less Carlots
Aluminum hydrate (Al $(OH)_3$)	lb.	.026-.029	.03½
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Antimony oxide (Sb_2O_3)	lb.	.14	.14½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03½
Barium nitrate ($Ba(NO_3)_2$)	lb.	....	Open price.
Pyrophyllite, (20% Al_2O_3)	ton	9.00	12.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.07½-.08	.08¼-.08¾
Tin Oxide (SnO_2) in bbls	lb.	Open Price	
Titanium Oxide (ceramic grade)			
In bags	lb.	.12	.12¼-.12¾
In barrels	lb.	.12¼	.12½-.13
Zinc Oxide (ZnO)			
American process, Bags	lb.	.06¼	.06½
White Seal, 150 lb. bbls	lb.	.08¾	.09
Green Seal bags	lb.	.08	.08¼
Domestic White Seal bags	lb.	.08½	.08¾
Red Seal, bags	lb.	.07½	.07¾
Zircon			
Refined Granular (Milled .01-.02c higher)		.06½	.07-.08

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	....	1.40-1.60
(Commercial, 25% Selenium)	lb.	....	.85
Cadmium sulphide (CdS)	lb.	....	1.00-1.05
Cerium hydrate—			
100 lb. drums and 600 lb. barrels	lb.	....	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	....	.22-.25
Chromite (99% through 200 mesh)	ton	40.00	44.50
Chromite ore (air floated)	ton	55.00	58.00-73.00
Cobalt oxide (Co_2O_3)			
In bbls	350 lbs. or more, lb.	....	1.84
	Less than 350 lbs., lb.	....	1.94
Copper oxide—			
Red (Cu_2O)	lb.	....	.165
Black (CuO)	lb.	....	.18-.19
Black prepared	lb.	....	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	....	.0425-.09
Black (Fe_3O_4)	lb.	.04½	.09
Iron Chromate	lb.	....	.035-.05
Lead Chromate ($PbCrO_4$) in bbls	lb.	....	.135
Manganese, Black Oxide			
In Paper bags	ton	62.50	65.50
In Burlap bags	ton	64.25	67.25
In Casks	ton	66.50	69.50
Neodymium oxalate, 50 lb. drums	lb.	....	3.50
Nickel oxide (Ni_2O_3), black	lb.	....	.35-.40
Nickel monoxide (NiO), green	lb.	....	.35-.37
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals and Granular	lb.	.08¾	.09-.09¼
Powdered	lb.	....	.09¼-.09¾
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	....	.27
Powder blue	lb.	....	.19-.24
Rare earth hydrate—			
100 lb. drums	lb.	....	.35
325 lb. barrels	lb.	....	.30
Selenium (Se) In 100 lb. lots	lb.	....	1.75
In lesser quantities	lb.	....	1.85
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.06¾	.07-.07¼
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	.08¼	.08¾-.08⅞
Sodium selenite (Na_2SeO_3)	lb.	....	1.50-1.65
Sodium uranate (Na_2UO_4) Orange	lb.	....	1.75-1.85
Yellow	lb.	....	1.75-1.85
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	....	2.65-2.75
Yellow orange	lb.	....	1.75-1.85

Polishing Materials

		Carlots	Less Carlots
Emery, Turkish	lb.	.063	.07
Pumice Stone,			
American Ground Italian FFF, FF, F	lb.	....	.03
0, 0½, ½, 1.	lb.	....	.04
Putty Powder	lb.	Open price.	
Rotten Stone, (Domestic)	lb.	....	.03½
Rouge, Red	lb.	....	.16
Black	lb.	....	.18

MEET COMPETITION WITH "Ceramic"

colors · chemicals · supplies

"CERAMIC" PRODUCTS FOR GLASS

•

COLORS
Alkali Resisting
Acid Resisting
Satin Etch Finish
High Fire Convexing
Low Fire
Squeegee Colors—
Dry or Paste

ENAMELS
White
Colored
Weather Resisting

ICE
Colored or Crystal

OILS
Squeegee Oils for low fire, high fire, or overlapping work
French Fat Oil

DECORATING SUPPLIES
French Camel Hair Brushes
Spatulas and Palette Knives
Color Grinding Porcelain Mills
Bronze, Iron or
Buhrstone Mills

Decoration of glass has become the most powerful force in glass sales—whatever you manufacture.

"Ceramic" products for glass are manufactured with today's processes and problems in mind.

Whatever color you want, for whatever process, "Ceramic" can match it with a pretested, uniform product which will return profits in lower production costs and increased sales appeal.

OUR CATALOG IN CDB CERAMIC DATA BOOK

CHEMICALS

Alumina Hydrate Antimony Oxide Arsenic Oxide Barium Carbonate
Boric Acid Borax Bone Ash Cadmium Sulphide Chromium Oxide
Cobalt Oxide Copper Oxide Iron Chromate Iron Oxides
Fluorspar Kryolith Manganese Dioxide Sodium Uranate
Sodium Selenite Selenium Sodium Silico Fluoride Zinc Oxide

"Ceramic" COLORS

CERAMIC COLOR & CHEMICAL MFG. CO.

NEW BRIGHTON, PA., U.S.A.

G.C.A. AT WHITE SULPHUR

(*Continued from page* 281)

Dr. Preston himself discussed this last mentioned feature of the work, and did a most remarkable job of explaining a highly technical subject intelligibly to the layman. First calling attention to the variety of meanings given to the term "striation" by the different branches of the glass industry, he stated that his laboratory had segregated cord from the matrix which had been turned over to Dr. Turnbull, a physicist, for study. Finally Dr. Turnbull had developed a means for measuring the degree of cordiness, in terms of temperature, which showed the differences in their density. The problem of cord will be studied intensively from a chemical standpoint by a full time chemist who will be added to the staff on June 1. Dr. Preston noted that this project involved practically a virgin field of research, and also that the work was necessarily very slow and difficult due to the small quantity of glass involved in the analysis. It probably will require two or three years to complete. Meanwhile, results so far obtained indicate that present knowledge of cord is for the most part wrong.

Work With Other Associations

The Glass Container Association is cooperating with the suppliers of packaging machinery to effect a better understanding of each other's problems. It is hoped that by this effort packaging methods can be simplified, and the cost of packaging in glass reduced. This should prove a stimulus to expanding the market for glass containers. Definite results already have been secured in the dairy industry. A cooperative effort with the brewing interests has paved the way for beer bottle standardization.

Traffic

Transportation legislation now being considered by the House and Senate Conference Committee is not expected to contain provisions unsatisfactory to the glass container industry. When enacted, the statute will provide for rate investigations, and undoubtedly there will be eventually a revamping of the freight structure throughout the United States. The investigation probably will cover such matters as the relative economy and fitness of rail and the motor trucks to transport the different descriptions of traffic, whether for long or short haul.

Trade Promotion

In the *milk* field, the threat of the two-quart paper container seems to be slackening. Quite recently, one of the two largest New York City dairies admitted they had failed to show a profit, despite an intensive five-month promotion. On the other hand, the two-price plan of selling milk is gaining ground, and under this price plan the single-quart bottle can be used most advantageously. The two-quart milk bottle also has proved its value. Design of this container has been standardized in cooperation with the dairy and equipment manufacturers.

Glass *beer* containers are maintaining their superiority over tin, the latter container being unable to increase its share of the packaged beer market beyond seven per cent. Sixty-eight brewers are now using the no deposit beer bottle. Studies have shown that brewers save $1.79 per barrel of beer over the can as a result of using this lightweight no deposit bottle.

J. M. McKINLEY DIES IN CLEVELAND

The entire world of American ceramics was shocked to hear of the recent death of John Milton McKinley, 57, vice-president in charge of operations and research of the North American Refractories Co., Cleveland, Ohio. Mr. McKinley died in a Cleveland hospital May 19, after an illness of three weeks following an operation.

Born July 29, 1882, in Shire Oaks, Pa., he was educated in the grade and high schools of Indiana and became a machinist in Pittsburgh at the age of 16. Shortly after he became a protege of the late John A. Brashear and in 1900 began to work for the Carnegie Steel Co. at Clairton, Pa., where he rose in four years from draftsman to superintendent of construction. Then began his long association with the fire brick industry, his first job being with the Fayette Fire Brick Co., Uniontown, Pa. In 1909 Mr. McKinley transferred to the Crescent Refractories Co., of Curwensville, Pa., of which company he later became vice-president and general manager. When his company merged with others in 1929 to form the North American Refractories Co., he became vice-president in charge of operations and research of the new organization, a position which he held at the time of his death.

More than twenty years ago he pioneered the standardization and classification of refractory materials with what is now the American Refractories Institute and for some ten years was a member of the Technical Advisory Committee of the organization. He also served the A. R. I. for one year as vice-president and two years as president. Mr. McKinley was an active member and Fellow of the American Ceramic Society and was president of the society in 1935. Other memberships included the Institute of Ceramic Engineers, Keramos, and the American Society for Testing Materials, of which he was president for a term. He was a trustee of the Edward Orton, Jr., Ceramic Foundation.

John M. McKinley's contributions to the scentific development of the art of refractory manufacture have probably been as numerous and important as any. Blessed with a scientific turn of mind, he never lost the practical touch gained through long experience in manufacturing, sales and research. His achievements were recognized on June 10, 1936, when he received the Professional Degree of Ceramic Engineer from Alfred University.

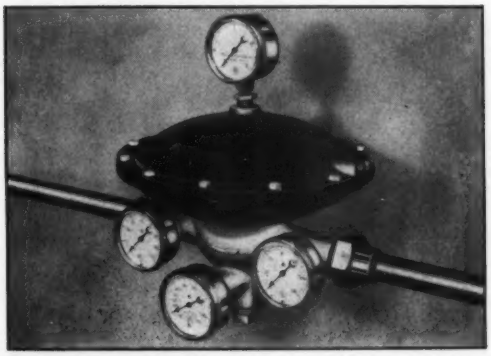
He was even more widely known for his accomplishments in the field of photography, to which avocation he brought his scientific bent as well as cultural and artistic tendencies. His photographic studies have been exhibited in salons throughout this country and abroad and have brought him well-deserved fame. Several years ago Mr. McKinley received a fellowship in the Royal Photographic Society, London, and he was a director of the Cleveland Photographic Society for a number of years. He was active in the formation of the Ceramic Camera Club and recently began his second term as chairman of its board of governors.

WILLIAM PEACOCK, JR., DIES

William Peacock, Jr., founder and president of Peacock Laboratories, Inc., Philadelphia, a subsidiary of the Libbey-Owens-Ford Glass Company since December, 1939, died in that city May 20 of a heart ailment. Mr. Peacock was the discoverer of the revolutionary mirror silvering process announced early this year.

READY FOR ACTION

• On major industrial battle fronts all over the country, the North American AIR-OIL RATIOTROL is winning decisive victories over the forces of waste and uncertain results in oil fired furnaces.



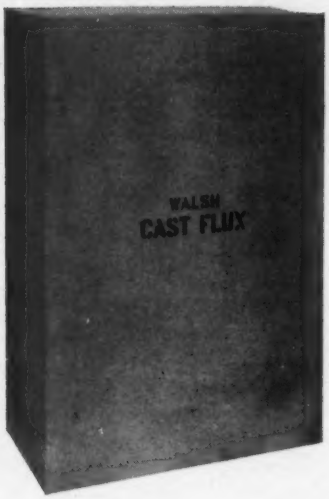
• By proportioning the flow of fuel oil and its combustion air through pressure, perfect control is assured at every instant. Air pressure becomes the dominant factor while number of burners and their individual settings have no effect on the operation.

• Non-varying air-oil ratios are maintained when changing size of fires . . . . turning individual burners up and down . . . . changing air or oil supply . . . . adjusting air-oil ratio on any individual burner.

NORTH AMERICAN *for* COMBUSTION

MANUFACTURING COMPANY . . . . CLEVELAND, OHIO

WALSH CAST-FLUX



The Vacuum-cast flux block of superior quality.

Walsh Cast-Flux blocks are machine-trued to exact size and shape after burning.

THEY LAST LONGER

The excellent results obtained in numerous tanks melting various types of glass has definitely established the efficiency and economy of Walsh Cast-Flux blocks.

Walsh Cast-Flux has a dense, uniform structure; it is burned at higher temperatures, is thoroughly bonded and possesses a low coefficient of expansion.

Walsh Cast-Flux blocks meet the most rigid requirements for tanks operating at higher temperatures . . . they insure greater tonnage, higher quality glass, freedom from defects, longer life and maximum economy.

WALSH REFRACTORIES CORPORATION

Manufacturers of Refractories for the glass industry for over 50 years

4428 North First Street
St. Louis Missouri

URBANA CONFERENCE

(*Continued from page* 276)

glass composition, nature of traces of metals, and differential rise in pH of liquid stored in glass. Chemical durability is a very serious problem from the distiller's standpoint and it is hoped that Mr. Herman's paper will lead to more extended investigations.

Comments by A. K. Lyle, Hartford-Empire Co., were presented by W. E. Loomis. Mr. Lyle stated that the Seagram specifications represent a direct approach to the problem of chemical durability and one that can be made by other users of glass bottles. Some have already done so and there are now probably a half dozen tests and specifications imposed upon bottle manufacturers. The possible combinations and permutations of these tests are almost infinite, but all have the common purpose of assuring that the bottle furnished by the glass manufacturer will be satisfactory in use. The number of glass compositions are relatively few and somewhat limited, however, and from the standpoint of the manufacturer only a small number of tests would be required for predicting the service performance of bottles. Continued cooperation between users and manufacturers in the study of chemical durability is necessary for some simplification of test which will be mutually satisfactory.

To a question by Norbert Kreidl regarding the treatment of the bottle with compounds of weak acids, Mr. Herman replied that such treatment does some good but that the coating comes off and introduces strange salts into the products. U. E. Bowes, Owens-Illinois Glass Co., referred to a paper given by Bacon and Burch at Skytop last year and published in the Journal of the American Ceramic Society.

Use of the Employee's Suggestion Box in Glass Factories. *By J. N. Martin, Pitney Glass Works of the General Electric Co., Cleveland, Ohio.*

Many employee suggestion plans pay a predetermined prize or award, based on the merits of the suggestion as compared with other suggestions during a given period; others evaluate the suggestions in money, based on expected savings; but the plan in operation at Pitney Glass Works is also used to sound out trends of employee thought. Before the final plan was evolved several requirements were considered. A method was wanted to keep personal touch between management and employees without being too cumbersome; it was also felt that many small ideas were being wasted for lack of a suitable clearing-house for collecting these ideas and holding them until they could be carried out; and finally it was felt necessary to drive home the point that advancement in position or rate of pay would be the real payoff for initiative, cooperation, interest and originality. A bargaining proposition, in which the employee sells something for which he may get less than he thinks it is worth, was certainly to be avoided and, under the present plan, the awards are simply an inducement to participate in the plan.

Controlled Tank Pressure and Combustion. *By I. G. Fowler, Libbey-Owens-Ford Glass Co., Ottawa, Ill.*

After considerable experience in the continuous formation of plate-glass sheets up to 90 in. wide, the Libbey-Owens-Ford Glass Co. began in 1934 an experimental tank production of a rough glass sheet 140 in. wide at Dunbar, W. Va. Meanwhile the Pilkington Bros. Co, St. Helens, England was developing and improving the flow-type process originally begun by the Ford Motor Co., and drawing plate glass in wide sheets. In 1936, L-O-F licensed the English flow-type process and the construction of a complete tank layout was started at Ottawa, Illinois, early in 1937. This included a new modern batch house, water treating plant, tank, lehr, gas producers, and other extensive mechanical and handling facilities. (Described in THE GLASS INDUSTRY, April, 1938.—Ed.)

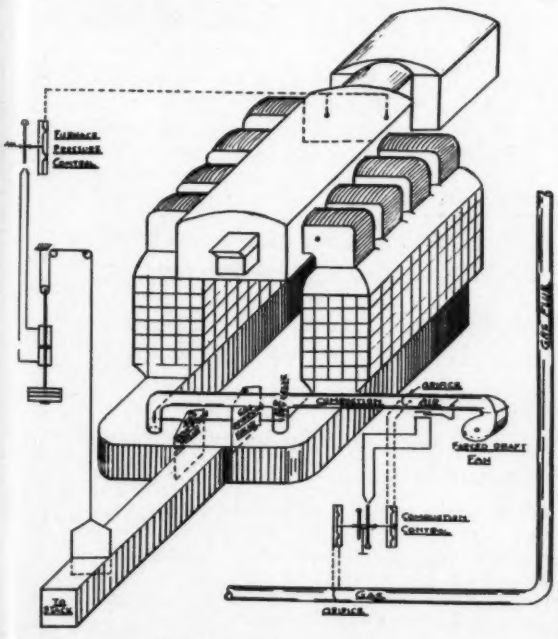
The new tank was equipped with an automatic pressure control, following what seemed to be successful practice in the steel industry, and this automatic regulation of pressure

in a glass tank seems to be the most important means for regularity of operation, uniformity of temperature, fuel economy, and color and quality of glass. When a sub-atmospheric pressure is carried in a natural-draft tank, a high draft is required to overcome checker resistance and maintain the desired melting rate, but this heavy draft causes infiltration of cold air into the furnace and regenerators. The first effect is a reduction in furnace temperature; a secondary effect is an increase in the quantity of waste gases and a decrease in their temperature. The increase in waste gas volume increases the velocity of the outgoing gases, resulting in an increased carry-over of slag, vapors and finely divided particles of the charge. Furthermore, excess air in the furnace shortens the flame and causes localized high temperatures which tend to reduce the melting rate.

In most furnaces where high pressures are carried, the pressure condition has built up over a period of years, during which the tank and regenerators have been enlarged to meet increased production requirements. Unless particular attention is also given to the stack and flues, the products of combustion cannot be drawn out as fast as formed and a high furnace pressure results. No pressure control is useful on such a tank because the damper is always wide open anyway.

For the Ottawa tank the Askania control mechanism was selected because of its ruggedness, accuracy and apparent freedom from operating troubles. After overcoming some mechanical troubles in the early stages of the first campaign, the tank produced some very excellent glass and was considered successful. The first run was completed February 15, 1939, after a total operating period of 345 days.

The tank was rebuilt and again fired up on June 10, 1939, but this time natural gas was used as fuel and it was decided to add combustion control to the furnace, after some experimental work at the Charleston plant. This control began operation in September, after determination of a satisfactory fuel-air ratio by observation and analysis of waste gases. The ratio can be changed as desired. The accompanying diagram shows the present controls on the



Ottawa tank, the installation not being very complicated because combustion air had always been supplied by a fan. It is now possible to set the gas feed at any desired amount and rely upon the mechanism to give just the right amount of air at all times. A means is also provided to compensate for a variable differential between air and gas temperatures. At Libbey-Owens-Ford both the automatic pressure control

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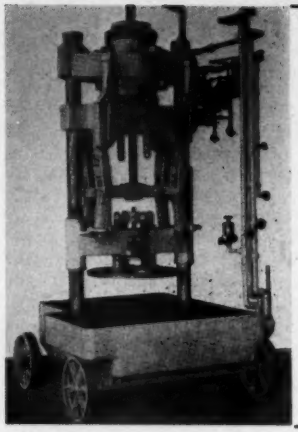
and the automatic combustion control are now considered essential for good tank operation.

Discussion: In a prepared commentary, F. E. Early of the Askania Regulator Co. mentioned the theoretical pressure to be maintained in glass melting furnaces. In order to eliminate infiltration, the pressure at the glass level must be at least zero, or a balanced pressure between the inside and outside of the tank. Unfortunately, due to chimney effect in the furnace proper, the pressure increases with distance above the glass level, the amount of increase being approximately 0.01 in. W. C. for each 10-inch rise when the furnace temperature is around 3,000° F. Calculations on a hypothetical furnace, in which the furnace pressure at the crown was 0.01 in. too low, indicated that approximately 550 lb. of air at room temperature would infiltrate per hour. This would necessitate an additional fuel consumption of about 360 cu. ft. of 1,100-B.t.u. natural gas per hour. Slight pressure variations produce sufficiently detrimental effects to justify their prevention.

A communication from H. H. Hanna, Pittsburgh Plate Glass Co., Crystal City, Mo., was read by J. A. Slaughter. Mr. Hanna described briefly the operation of the Leeds & Northrup pressure control installed on the tank at Crystal City. This control differs from the Askania in that it is of the electrically operated type, but the results obtained are similar to the Ottawa installation. At Crystal City the tank pressure is adjusted by the operator to keep the temperature in the nose of the tank within close limits.

G. H. Terrill mentioned the excellent results obtained with three Askania pressure controls at the McKee Glass Co. Commenting on the adjustment of pressure for temperature control, R. L. Shute spoke of the possibility of glass temperature control through the use of a water-cooled thermocouple in the glass. W. F. Curtis, Fostoria Glass Co., described a means for holding a uniform temperature in the combustion air, the air being drawn from two sources, one warm and one cool, with an arrangement to adjust the amount of air drawn from each source.



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INVENTIONS AND INVENTORS

(*Continued from page* 279)

drawn from the tank. Cracks or checks starting during the cutting operation, or due to stones or other defects, are said to have a great tendency to spread toward the point of generation of the sheet. The Spinasse invention, as shown by Fig. 6, proposes to equip the fireproof belts 8, which direct the sheet, with one or more electrical resistors 18, which may be heated to the temperature of the drawn glass, if desired. It is claimed that a crack or check will not extend beyond the line where these heated resistors contact the glass.

In heating plate glass for tempering, Lewis Jex-Blake Forbes, of St.Helens, England, has found an advantage in a multi-stage furnace operated so that more than a directly proportionate amount of the temperature rise is accomplished before the last furnace is reached. This is patent 2,198,622 assigned to the American Securit Co., of Wilmington, Delaware.

An apparatus for polishing glass sheets was patented by Dwight D. Dwight D. Johnson of Versailles, Pa. (2,199,135). Patent 2,197,560 for an apparatus for cutting traveling sheet glass was granted to John H. Moller of Charleston, W. Va. (Libbey-Owens-Ford Glass Co).

New Products and Uses

This claim of unusual breadth was granted to Dr. J. T. Littleton of Corning Glass Works: "As a new article of manufacture, a glass line insulator which has been tempered." This is patent 2,198,734.

Gerald E. Reinker of Cleveland, Ohio (General Electric Co. patent 2,197,562) obtained a patent for fritted glass articles to be made of a mixture of two glasses having different softening points. Powders of the two glasses with a predominance of the more refractory one, are pressed together to form small insulators and are then heated to a temperature sufficient only to melt the less refractory glass.

The Owens-Corning Fiberglas Corp. was assignee of patents 2,197,004 and 2,198,620 which are concerned with uses of glass wool. The first of these patents was granted to Frank L. Myers of Toledo, and is concerned with air filtering apparatus. The second patent, granted to Jan S. Irvine, also of Toledo, utilizes glass wool in the platen of a clothes pressing machine.

Hans Schuhmann, Berlin-Frohnau, Germany, assigned to General Electric Co. his patent 2,196,033 for a resin molding compound containing filaments of glass having particular characteristics. The fibers are intended to increase the strength of the heat-hardened resin.

A hollow glass block containing wire mesh reinforcing in each half was patented by Harold L. Eastus of Muncie. (2,196,109 to Owens-Illinois Glass Co.)

Patents 2,197,913 to Roy T. Axe of Syracuse (O. M. Edwards Co.) and 2,197,557 to Clyde D. Lowry of Toledo (Libbey-Owens-Ford), covered window and sash details. Mr. Lowry also patented a glass-topped drawing board (2,197,556).

Details of construction for a light transmitting structure utilizing glass blocks was patented by Jack O. Chertkof of Baltimore (2,198,450).

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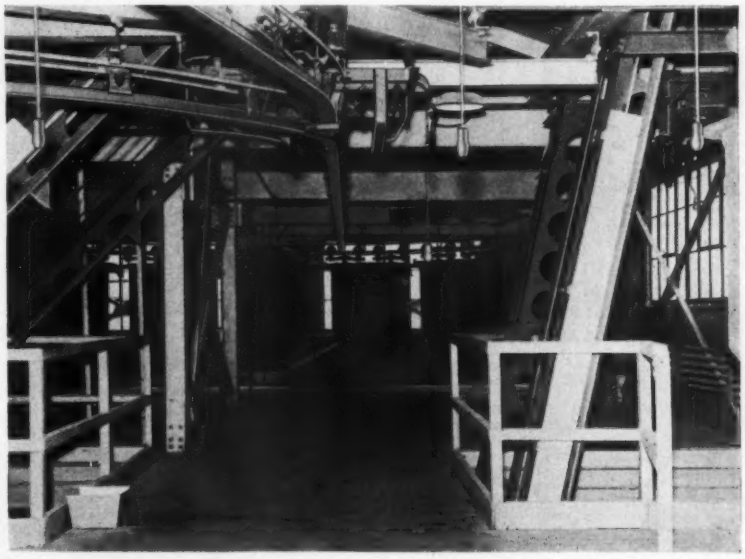

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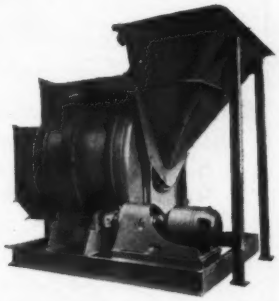

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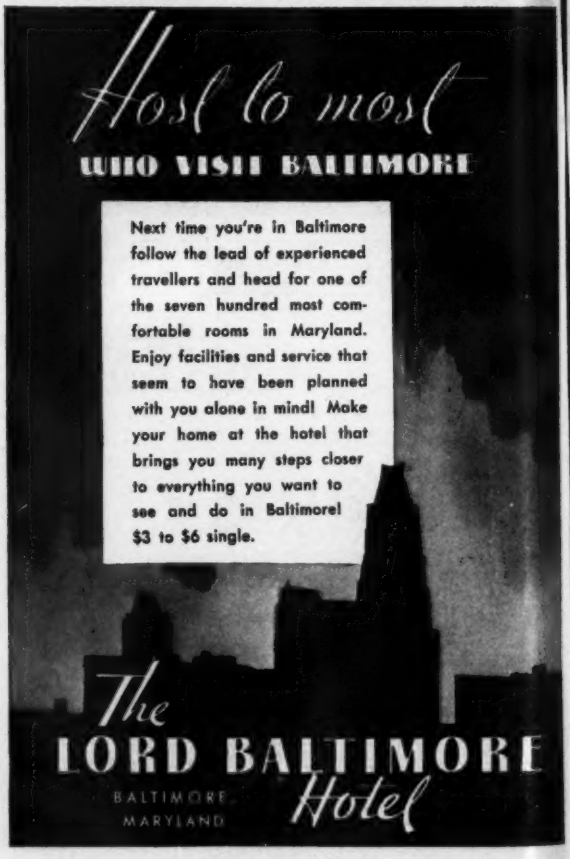
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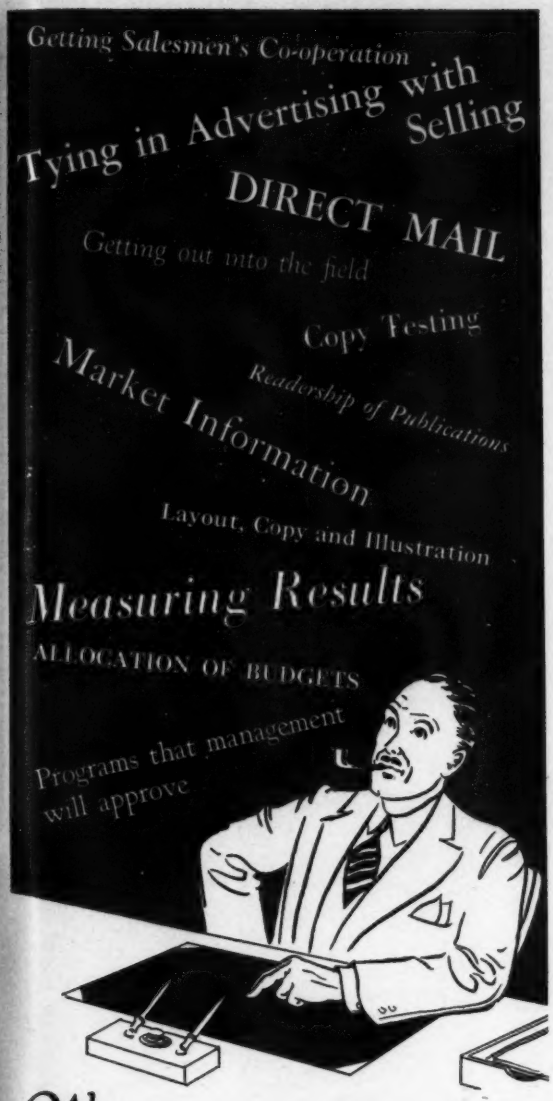

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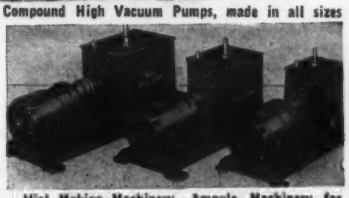

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